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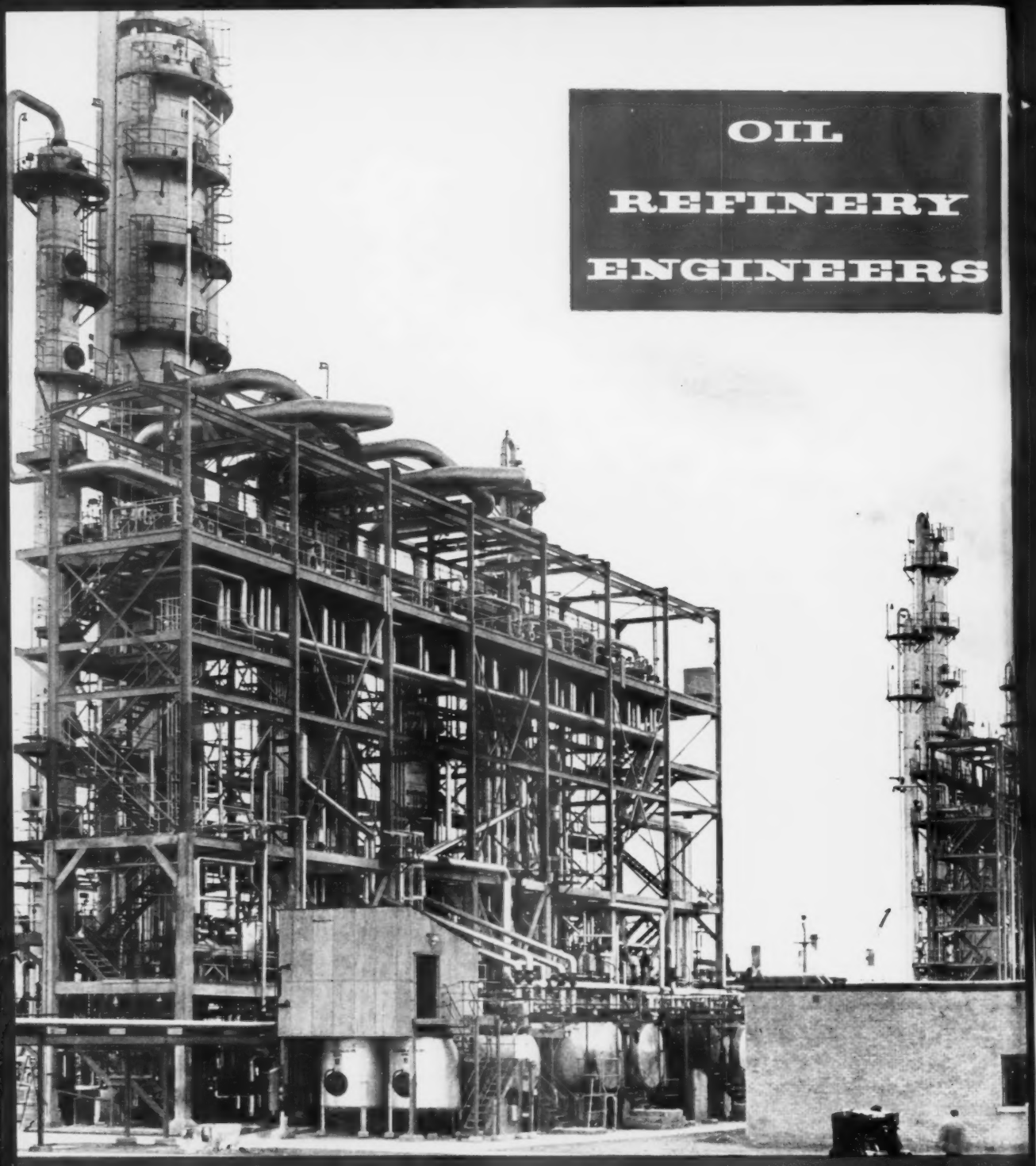

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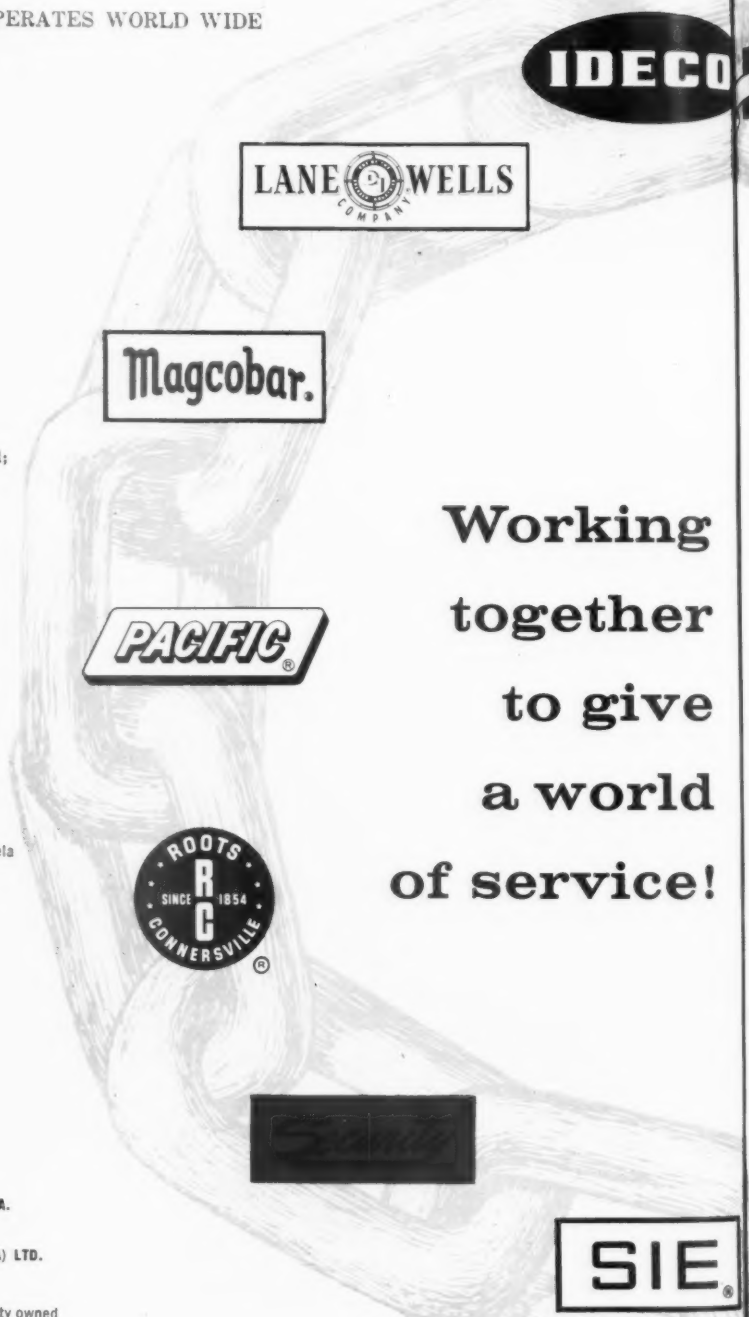

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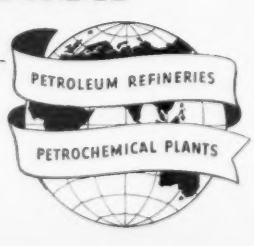

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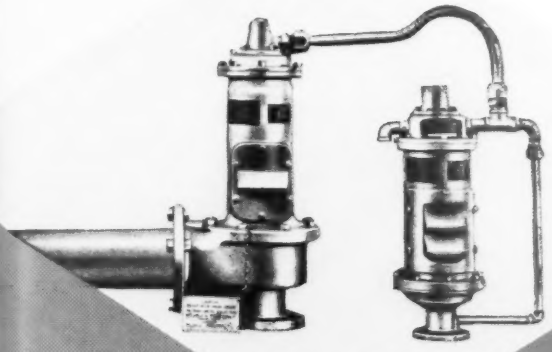

FIG. ST-2500
Safety Valve

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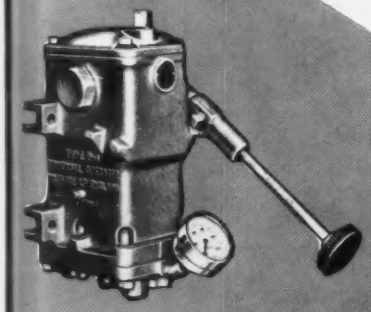


FIG. 13434
Hydraulic
Operator

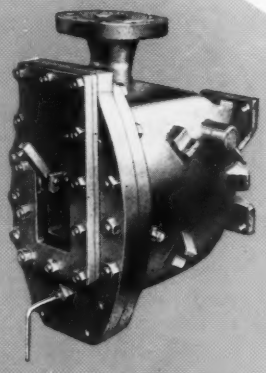
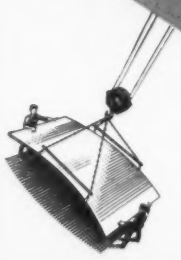


FIG. ST-9400
High pressure
Gauge



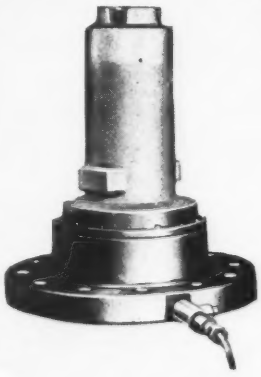


FIG. 13800
Hydraulic
Valve

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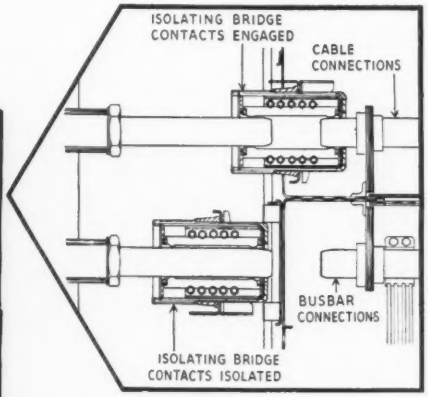

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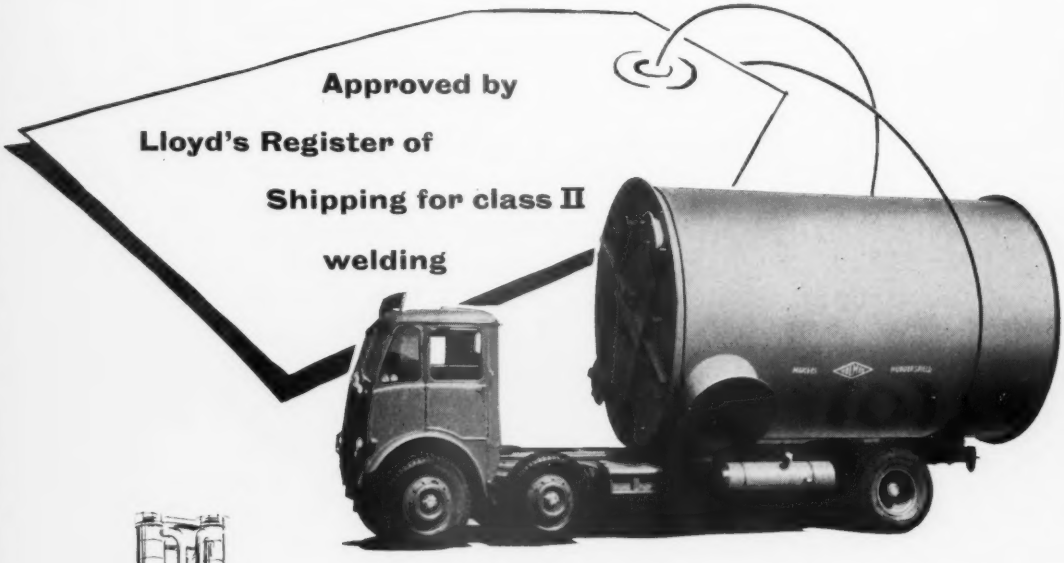

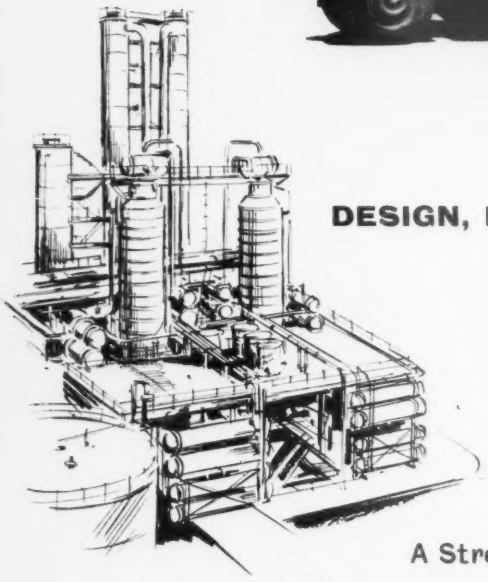

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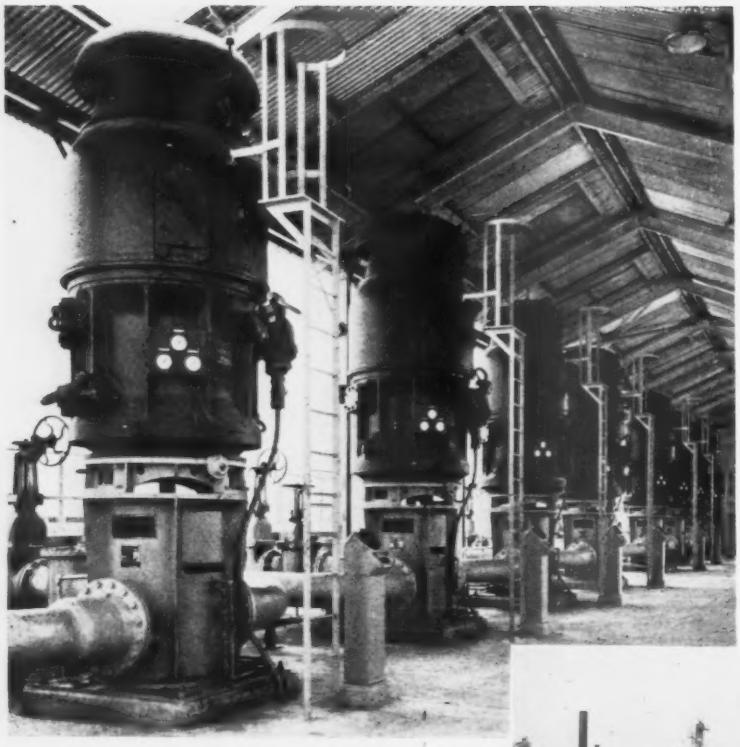

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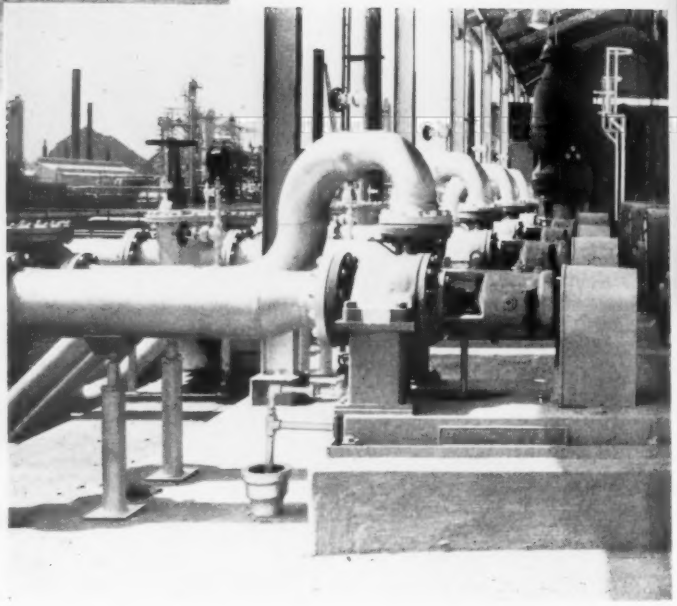

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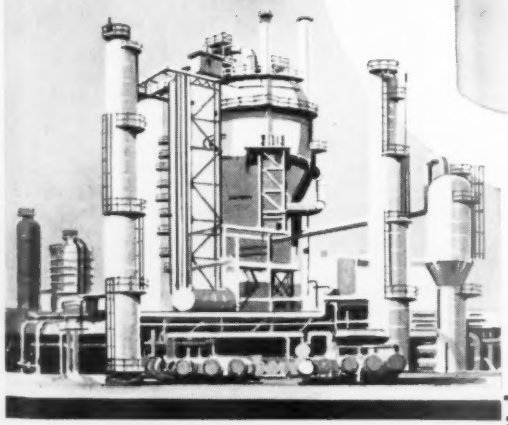

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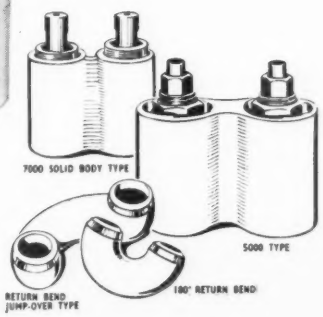

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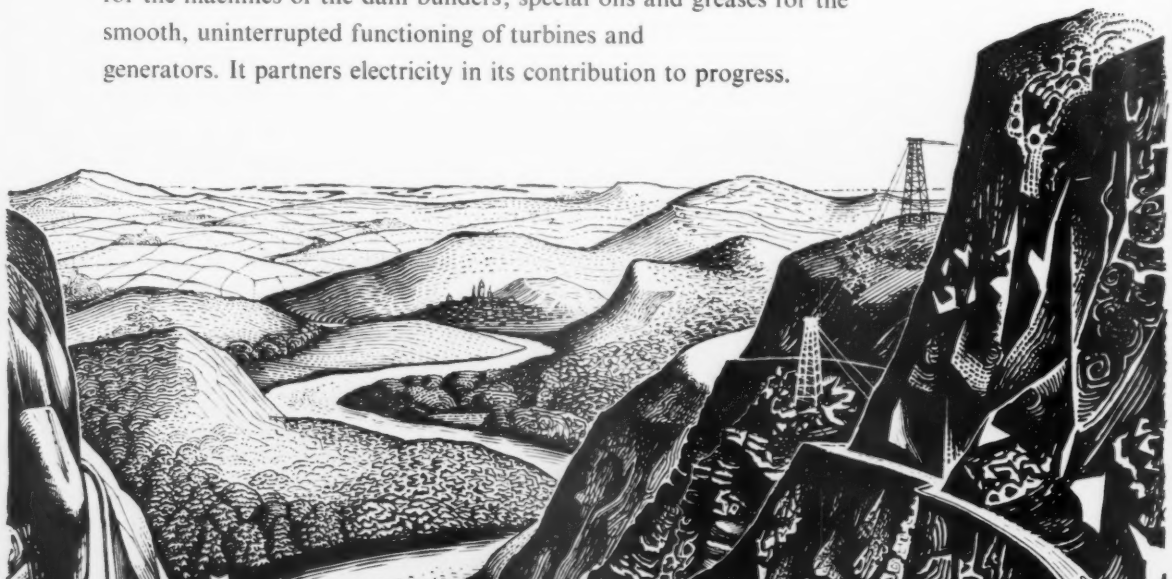

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REVIEW

Volume 12, No. 135 March 1958

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*Oil Prices in 1957**

By E. A. HIGGINS†

In this paper the words "oil prices" are taken to apply only to the prices of crude oil and main bulk products when sold in cargo lots at main world export centres, together with considerations of freight to destination. The paper does not touch on wholesale or retail prices in local markets, nor under "main bulk products" are included any special products such as lubricants or bitumen, even if sold in bulk cargo lots. The "world", is taken to mean the Free World, excluding the U.S.S.R. and satellite countries.

The outstanding feature of 1957, in the context of world oil prices, was the closure of the Suez Canal. But, if this review were to be limited strictly to the calendar year 1957, the starting point would be at a time when the effects of the Canal closure were at their height, and, even exactly one year ago to-day (Dec. 1957), the abnormal conditions of closure would be in operation. It seems better therefore, in order to see the year in perspective against the background of the whole Suez episode, to take as the starting point the last convenient date when the Canal was still open, namely, 1 November 1956.

Even this is not entirely free from the effects of Egyptian activities, since, from July onwards, freight rates had been hardening in anticipation of restrictions on the passage of tankers through Suez. The spot market rate, which had averaged scale +65 per cent for the seven months prior to nationalization of the canal, had already soared to around scale +275 per cent. Even a "stabilized freight" indicator such as AFRA rose, at the beginning of the fourth quarter, to scale +41·3 per cent, against an average for the first three quarters of 1956 of scale +31·4 per cent.

Oil prices however had not yet reacted to any abnormal influences. During September/October there had been the expected small seasonal drop in motor gasoline prices in the U.S. Gulf and a similar small increase in kerosine and No. 2 fuels. On 1 November Platt's Oilgram reported low U.S. Gulf prices per American gallon for motor gasoline 90 octane at 11·0 cents; kerosine at 9·5 cents; gas oil 48 diesel index at 8·875 cents; and C grade fuel oil at $2·10 per brl. As regards crude oils, the field price of West Texas sour 29° API stood at $2·55/brl; in the Caribbean the posted price of Meneg Mesa 30° API, from the Oficina area, was $2·57 and that of Bachaquero 14·5° API was $1·76. In the Middle East Arabian 34° API was posted at $1·93 f.o.b. Ras Tanura.

Oil Prices December 1957

How do to-day's U.S. Gulf prices compare with these? To-day, the low U.S. Gulf price for 90 octane motor gasoline is 10·75 cents/U.S. gal., ¼ cent *down* from last year after rising to a peak, during the Suez closure, of 11·5 cents; kerosine, after a peak of 10·75 cents, is *down* to 9 cents, half a cent below last year; gas oil 48 diesel index is ⅜ cents *up* at 9·25 cents, after a peak of 10·5 cents; and C grade fuel is 45 cents/brl *up* at $2·55, having risen meanwhile to a peak of $2·75. Over the year, therefore, gasoline and kerosine prices have fallen appreciably, gas oils have strengthened, and there has been a substantial increase in posted prices for fuel oil. Crude oil prices, at the same time, have all increased: West Texas sour by 25 cents to $2·80; Venezuelan light crudes, such as Meneg Mesa, by a similar amount; and heavy crudes like Bachaquero by double that amount, up 49 cents from $1·76 to $2·25. Middle East crudes, over the same period, have risen on average some 13 cents/brl.

Price and Market Comparisons

The broad outlines of a comparison of the situation now with the situation at 1 November 1956 are clear enough. While crude oil prices have risen (the heavy crudes more than the light and those in the Western Hemisphere more than those in the Middle East), overall product price levels have not substantially changed. But there have been some relative changes, notably a reduction in gasoline prices and a higher price for fuel oil. The level of average freight rates, discounting the slight element of anticipation in the fourth quarter of 1956, is virtually unchanged, although, if one looks solely at spot rates, the contrast between the exceptionally high levels of the autumn of 1956 and the exceptionally low rates now current is very marked indeed. Apart from the actual prices and freight rates there are some changes also in market sentiment. Both then and now, there was a sluggish tendency in the market for gasoline, with stocks high and cargoes seeking a market, but whereas last year the market in fuel oil was firm with supplies not readily available in the Gulf/Caribbean area, to-day the market in fuel oil is relatively less buoyant.

*Read at a meeting of the IP Economics and Operations Group on 19 December 1957.

†Shell Petroleum Co. Ltd.

Trend of Demand

And to-day, overriding all considerations of individual products, there is evidence, for the first time for many years, of a temporary slackening-off of the rate of increase in the total world demand for petroleum. As regards the United States, in November 1956, the Bureau of Mines estimated a total domestic demand during 1957 at 8·76 million b.d. By November 1957, this estimate was revised downwards to 8·42 million b.d. Actual demand for the first nine months of 1957 was less than 1 per cent above that for the comparable period in 1956, whereas the average annual increase had hitherto been running at around 4 per cent. For the free world excluding the United States, the story is similar. Estimates made in November 1956 for 1957 demand were for 6,815,000 b.d. but, by November 1957, the 1957 demand estimate was revised to 6,695,000 b.d., showing an increase of less than $7\frac{1}{2}$ per cent over 1956 levels, compared with increases over the period 1948 to 1956 ranging from some 8 per cent to some 13 per cent and averaging 11·4 per cent.

The Suez Closure

Between 1 November 1956 and now, the major event in the world of oil was the temporary closure of the Suez Canal and the severance of the pipelines to the East Mediterranean. To what extent can such significant price changes as have emerged over the period be ascribed, directly or indirectly, to the "Suez episode"? To what extent do prices and market conditions to-day still bear the imprint of the disturbances which Suez inflicted on the otherwise orderly pattern and orderly development of world oil prices? These are the questions which are very briefly considered in the following sections.

Immediate Effects

The immediate effects of Suez were obvious and expected, and it is not very rewarding to examine them in detail. Broadly, however, because potential supplies of crude to N.W. Europe from its natural source in the Middle East were reduced, it turned in part to the Western Hemisphere as an alternative source. Owing to the disruption of normal supply routes, longer voyages, and the demand for increased tonnage, spot freights shot up to record levels. For example, by December, the freighting of a cargo of crude from the Persian Gulf around the Cape to Italy was contracted at 851·0 a ton or nearly $3\frac{1}{2}$ times the f.o.b. cost of the oil. Product prices, led by fuel oil, rose in stages by varying amounts, from 5 per cent for gasoline to about 15 per cent for distillates and nearly 30 per cent for residual fuel. The price of those crudes still available on short haul—in the Western Hemisphere and the East Mediterranean—rose accordingly, by some 10 per cent of their previous price level.

These were the immediate effects, but in some degree these effects were transient. With the end of the emergency and the re-establishment of normal supply sources and normal supply patterns, increases in spot freight rates and in most product prices largely subsided. It is the changed relationships which did not entirely disappear, which have emerged as apparently permanent developments in the world oil price structure, with which the paper is more concerned.

How Oil Prices Move

Oil prices tend to be stable, for many reasons. Both the demand for and supply of oil has shown itself to be, over the long term, inherently far more stable than is the case with most other basic commodities entering world trade. Seasonal fluctuations apart, the demand for oil moves primarily in conformity with the level of economic activity, and has been shown, in a paper read to the IP on 6 November 1957, to be more stable even than the latter. The supply of oil has tended to keep pace very closely with the steadily increasing demand, and both demand and supply are relatively insensitive to price changes over the short term. As a result of this inherent stability, and perhaps in part also because of the industry's natural preference for orderly progression, changes in oil prices tend to be small, infrequent, and cautious. Therefore, even while prices and price relationships remain visibly unchanged, stresses may be building up until something happens to release them.

Suez as an "Accelerator"

It seems that stresses of this nature had been building up prior to Suez and that the enduring importance of the Suez emergency was that it was an event which released such stresses. Those new price patterns which arose out of the emergency and have remained, instead of reverting to the pre-Suez pattern, may indeed reflect changes which were in any case, in a sense, due to take place.

Crude Oil Price Levels

One such change is undoubtedly the rise in crude oil prices. For some time prior to Suez, there had been talk of the inevitability of higher crude prices, prompted by considerations of the economics of crude oil production in the United States.

There had been no general rise in crude oil prices since mid-1953, despite the substantial rise in exploration and production costs meanwhile. Over the same period, products produced from a barrel of crude had risen in value some 5 per cent; the general level of costs, as indicated by industrial wholesale prices in the United States, had risen 7 per cent; and drilling costs in particular had long been causing concern, with estimates of the rise since 1953 varying between 15 per cent and 35 per cent. There may well have been substance in the contention that U.S. crudes were being sold in some cases below replacement costs.

However, raw material price increases can, in general, only be expected in times of strong demand for the end product. The sudden increase in demand for Western Hemisphere products brought about by the closure of the canal produced conditions in which it was possible for crude prices to rise, in stages, by some 25 cents/brl. Although this temporary increase in products demand has now largely fallen away, the increase in the price of Western crudes appears to have stuck.

The Middle East "Differential"

Another long-term tendency, always latent in the structure of world oil prices, is the increase in the differential in favour of Middle East crudes, as they seek wider and wider markets for their output. This tendency was reflected in the rise of Persian Gulf crudes by only 13 cents, on the reopening of the Canal, against the earlier rise of 25 cents in the price of Western crudes. In 1947 the differential between comparable crudes f.o.b. the U.S. Gulf and Persian Gulf respectively had been of the order of 50 cents/brl. By 1950 this had increased to 97 cents; in November 1956 it was 81·00. With the re-opening of the Canal, crude oil prices in the Persian Gulf, no longer insulated from West of Suez markets, moved up to a

level reflecting a realistic relationship, in the light of supply and demand, with Western Hemisphere crudes; and the new differential was established at a level of 81·12.

Light and Heavy Crudes

Another legacy of Suez which may well be regarded as a fundamental change in world oil price relationships is the reduction in the differential between light and heavy crude oil prices. In November 1956 the price of Meneg Bachaquero 14·5° API was 81·76 and that of Meneg Mesa 82·57, a differential of 81 cents/brl. To-day (Dec. 1957) the prices of these two crudes are $2·25 and $2·79 respectively, a differential of only 54 cents. This marked rise in the price of heavy crudes in relation to light cannot of course be disassociated from the final major change—that of the increase in the price of fuel oil in relation to other products. Whereas the prices of other products subsided, with the re-opening of the Canal, to within a few points of their levels prior to the Canal closure, the price of C grade fuel has remained significantly above this level. This changed relationship may perhaps be read as an indication of the long-term trend towards an increasing demand for those products at the "heavy" end of the refinery run in relation to the lighter products. This shift of emphasis from the refiner's point of view provides a background against which the relative rise in the price of low-gravity crude oils seems both natural and inevitable.

Refiners' Margins

It is perhaps worthwhile to examine very briefly what effect all these changes in the price structure have had on refiners' margins, for it is at this point that the various influences of demand and supply on the two worlds of crude oil and petroleum products meet and interact. The difficulty in making any such examination is of course in deciding what to take as the typical refiner's experience, since so much depends on the crude intake, the refinery equipment involved, and the market pattern of demand to which he is refining.

However, taking any typical light U.S. or Venezuelan crude, within the 30°–34° gravity range, it seems that the value per barrel in terms of products, if refined by a process of simple distillation, had risen by between 23 cents and 28 cents over the period, thus roughly covering the 25 cents increase in crude prices. However, because of the relative drop in value of the lighter fractions, more complex refinery processes have been unfavourably affected. Depending on the actual processes employed, product yield values showed increases ranging from 4 cents to 16 cents on light Western crudes, against a crude price increase of 25 cents. Thus, although the gross margin, before allowing for operating costs and plant write-off, was still higher on complex refining processes than on simple refining to fuel oil, it appears broadly true, that, whereas the margin on simple refining had remained unchanged over the past year, complex refinery operations had become less profitable. This may be only a temporary phase, thrown up by the current slackness in the world demand for oil which, in conjunction with normal seasonal trends, had made itself disproportionately felt in the prices for lighter products. If so, with any recovery in the tempo of world economic activity, might one expect to see gasoline prices recovering something like their previous differential over fuel oil and a corresponding improvement in the relative profitability of complex refinery operations? Or should one instead regard this as yet another reflexion of the long-term trend towards the increasing relative importance of the role of residual fuels in the economics of the oil industry?

Products Prices in the Persian Gulf

There was one other important and interesting development which must be mentioned in any review of world oil pricing matters in 1957. That was the introduction of posted prices for products f.o.b. the Persian Gulf. In itself this development had no particular significance since it was no more than a logical and inevitable development of a practice already well-established in other world-pricing centres. What is more interesting is to consider how these openly published Persian Gulf products prices, established in a widely based free market, relate to prices in other export centres. Initially the levels posted were in line with the unpublished prices which had been used previously, and these unpublished prices had themselves been set by competitive considerations, having regard to local demand and volumetric availability, broadly in line with prices in the U.S. Gulf/Caribbean area. (They had not however followed in the same degree the strong upward tendency of product prices in the Western Hemisphere during the "Suez" period). In contradistinction to the crude oil situation, where Persian Gulf supplies far exceed East of Suez demand, total refined product output East of Suez is as yet no more than marginally surplus to requirements in that area. Whereas Middle East crudes must, in order to find their outlet, be priced below comparable crudes in the U.S. Gulf/Caribbean area, Middle East refiners can, in general, find markets for their total output at levels which do not reflect any element of freight disadvantage vis-à-vis Western Hemisphere supplies. However, in view of the different pattern of refinery out-turn, to meet the pattern of local demand with its high proportion of fuel oil and correspondingly lower proportion of the more valuable lighter products, this does not necessarily mean that the average refiner's margin in the Middle East markets is correspondingly higher than in the Western Hemisphere. Estimates of margins on typical refining schemes, using typical crudes in each area, suggest that the gross margin earned on refining to the local pattern of demand in the Indian Ocean area is about on a level with the margin earned on complex refining to a products out-turn pattern representative of U.S. East Coast conditions.

To what extent Persian Gulf products prices will now trace a course of their own, differing from that pursued by Western Hemisphere prices, remains to be seen. Certainly, there are differences between the two markets to which they apply, and, already, certain divergencies between the price patterns at the two centres have appeared. For instance, whereas kerosine—a product in relatively short supply East of Suez—is fractionally higher at Ras Tanura than in the U.S. Gulf/Caribbean, the price of C grade fuel at Ras Tanura of 82·40/brl compares with the U.S. Gulf/Caribbean price of 82·55. This lower price for fuel oil in an area in which, by volume of demand, it is the most important product might at first seem surprising. But it must also be remembered that, despite its *relative* importance, there appears *at the moment* to be no shortage of fuel oil in the Indian Ocean area, its natural local market; and the point of disposal of marginal surpluses lies West of Suez. Considerations of this kind, which reflect inherent differences from time to time between the conditions prevailing in the two markets, must have their due effect on prices.

Summary

The outstanding feature of 1957, in the context of world oil prices, was the closure of the Suez Canal, and its importance lay, not so much in its immediate effects, though certainly these were very forcibly impressed upon us at the time, as in those developments of which it was in no way the cause, direct or

indirect, but which it nevertheless, in a sense, brought about. These developments—namely, the rise in crude oil price levels generally; the increase in the differential between Middle East and Western Hemisphere crude oil prices; the narrowing of the differential between light and heavy crude oil prices; and the similar reduction in the gap between the price of gasoline and the price of fuel oil—had their cause, or causes, in certain long-term tendencies inherent in the structure of world oil prices. But, because of the natural stability of the world oil market, they might not have come about when they did, or to quite the extent they did, had it not been for the upheaval of the Suez episode. The phrase "cause or causes" is used advisedly, for oil prices find their levels through the complex interplay of a variety of diverse economic factors; and it would be difficult to single out any one cause and point to it as the sole, or even the predominant, influence. Nevertheless, these four main changes in price relationships during 1957 do fit into a coherent picture—that of a world wherein it is the "heavy" end of the refinery run which is becoming of increasing importance. How world oil prices will move in the future, whether this trend continues, as seems likely—and how in particular products prices in the Persian Gulf, posted for the first time in 1957, will behave—are matters on which no one to-day can hold any certain opinion.

Discussion

The speaker was asked whether it was right to be too confident of the strength of crude oil prices in view of the fact that both the trend of demand towards lower-valued black oils and the pressure for outlets of Middle East crudes, assisted by a fairly weak freight market, might tend to weaken the level of Western Hemisphere crude oil prices.

Mr Higgins began by emphasizing that his talk had been specifically restricted to the subject of oil prices in 1957 and that anything he might say about future developments should be taken, not as part of his formal comments, but just as a personal contribution to the general discussion. Turning then to the questions that had been raised, he suggested that, so far as the light and medium Western crudes were concerned, these would be supported by a continued demand for them in the U.S. market which was not to the same extent affected by the growing emphasis on fuel oil which was developing in the rest of the world; and that, as regards the heavy crudes, the demand for residuals in markets outside the U.S. should tend to increase their relative value although, over the short term, much would depend on the severity of the winter. As regards the effect of increased supplies of Middle East crudes, Mr Higgins said, that, though he would not like to be dogmatic, his opinion was that, over the long term, there would be a growing market in the U.S. for both Middle East and Venezuelan crude oils and that there was no reason to suppose that this must be accompanied by a depressive effect on prices in the Western Hemisphere.

There followed an interesting general discussion on the future levels of freight rates and the probable reasons for the relatively early strengthening of the spot freight market some months prior to the Suez closure. Mr Higgins was asked to comment on an article which had appeared in the *Financial Times* of that morning which had referred to the prevalence of rebates and discounts in some form or another although the level of published prices was being maintained. After making it clear that he was concerned primarily with the prices of cargo lots at main export centres and associated freights, and therefore, really, the cost of delivered oil, Mr Higgins commented that, on the one hand he understood there was indeed a tendency for marketers and jobbers, both in the U.S. and to some extent in Europe, to pare their costs and therefore their prices, in an endeavour to improve their competitive position and encourage demand. On the other hand, apart from the occasional supplier shaving his price for a very limited quantity, it could definitely be said that cargo prices at producing centres had indeed held up. Of course it was true that, in times of low spot freights, even with stable f.o.b. prices, there was room for undercutting in delivered prices by anyone who could pick up cheap tonnage, but he had seen no evidence of anyone trying to snatch a bigger share of the limited market by really serious price rebates.

On being asked what might happen to price levels if the anticipated expansion of Middle East crudes into the U.S. did not occur, because of a U.S. recession, Mr Higgins said he thought the recent slacking-off of demand must be purely temporary and that inevitably the time would come when the U.S. would find itself progressively unable to meet its energy demands without recourse to increasing imported oil. Assuming however that this did not happen, he felt that in these enlightened days there would be a rational approach to the problem rather than cut-throat competition between producers although there might indeed be a temporary reduction in crude oil prices. This was all prognostication and was assuming a continued recession in the U.S. which would have all sorts of repercussions which would make any prognostication both gloomy and difficult.

In answer to further questions, Mr Higgins said he thought that the appearance of independent producers in the Middle East could have a marginally depressing effect on prices but that anything more than a marginal effect was unlikely. Again, a raising of U.S. tariff business could also have a depressing effect on Middle East prices, but this would be in line with the trend, referred to in his paper, for the differential between Middle East and Western crudes to widen. Moreover, as he pointed out, it was a historical fact that these adjustments tended to take place, not by an actual lowering of prices, but by the prices of one commodity going up more slowly than another.

Asked if, in the absence of regulations of domestic supply in the U.S., prices would have held up as they had, Mr Higgins agreed that they might not have done so. In the absence of controlled production, and controlled imports, prices would, from the economist's point of view, drop to the level at which the marginal producer would be squeezed out and demand would overtake supply.

★ ★ ★

Indian Refinery Throughput up Nine Per Cent

Crude throughput at the Assam Oil Company's refinery at Digboi for 1957 totalled 113,969,000 gallons. This is a record for the Company and a 9 per cent rise compared with 1956.

Roughly half the products were consumed in the BOC marketing area of Assam, the remainder being despatched to markets in other parts of India, chiefly the north and north-eastern regions.

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First Three Places for British Cars in Australian Economy Run

The 1958 Australian Mobilgas Economy Run has been won by a Wolseley 6/90 driven by Eric Lane and S. Pomroy of New South Wales. This car recorded the extremely creditable figure of 62·95 ton-m.p.g. or 34·06 m.p.g. Second place was taken by a Standard Vanguard with 58·63 ton-m.p.g., and third by a Humber Hawk with 58·52 ton-m.p.g.

The ton-m.p.g. formula $\frac{\text{weight} \times \text{distance}}{\text{number of gallons}} = \text{ton-m.p.g.}$

was used to enable cars of different capacities and size to compete on equal terms.

French, Italian, German, Australian, and American vehicles were also represented.

In class A, up to 1100 c.c. a Morris Minor 1000 gave 55·23 m.p.g. over the 1224-mile course between Melbourne and Glenelg, near Adelaide.

Other Mobilgas Economy Runs are to be held this year in Britain, Belgium, France, Holland, Switzerland, and Italy, and as far apart as New Zealand and South Africa.

Around the Branches

BAHRAIN, ESSEX, FAWLEY, KUWAIT, LONDON, NORTHERN, SCOTTISH, SOUTH-EASTERN, SOUTH WALES, STANLOW, TRINIDAD

London Branch Dinner-Debate

It would be impossible to capture in writing the atmosphere of the London Branch Dinner-Debate, held at the Chatham Rooms, London, on 21 January. In spite of a comparatively small attendance, the debate which followed an excellent dinner was nothing if it was not entertaining and possibly instructive, although it is not suspected that the latter was intentional.

The motion for debate was "There is more art than craft in industry" and the ball was set rolling by Professor L. Dudley-Stamp, C.B.E., who suggested that in the days when craft was the thing which counted there was no need to advertise. He based this on the slogan that "good wine needs no bush". To-day, said Professor Stamp, to succeed one must advertise, and so art came before craft. Art was not used to advertise craft but to advertise a product irrespective of its value. Quality was not so important as art.

Sir Gordon Russell, C.B.E., M.C., director of the Council of Industrial Design, supporting the motion, said that both terms meant "skill" or "cunning or deceit" and asked what proportion of each was needed in industry. Except in those industries where design was of importance, art appeared to be confined to the package. Today the package was becoming more important than its contents. Therefore, it seemed that art was more important than craft.

Opposing the motion, W. D. H. McCullough, chairman of the Publicity Committee of the National Trust, said that since industry had taken over in Britain both art and craft had gone. One result of this was the slums of our big cities and the most beautiful islands ever created had thus been spoiled. Where one had industry it was impossible to have art or craft. The National Trust, said Mr McCullough, was working to preserve that small portion of art not crushed by industry and he pleaded with his audience to become members of the Trust at once.

Supporting the opposition, Miss J. Leslie-Gibson of the English Speaking Union of the Commonwealth, said that art should be equated to advertisements. The latter did much to improve the standard of living. Speaking of

The London Branch Debate evoked much interest

For the Motion

Professor L. Dudley-Stamp

Sir Gordon Russell

Chairman Jim Clark

Against the Motion

W. D. H. McCullough

Miss J. Leslie-Gibson

the fashion industry, Miss Leslie-Gibson said this was an an example. The best designers conceived a new fashion to satisfy the deep psychological urge in women to express themselves to the opposite sex as their ideal woman. The best fashions were copied by not-so-good craftsmen and she suggested that there was not more art than craft but that more craft was needed at the lower end of the scale.

Before putting the motion to the vote, Jim Clark, who acted as chairman in the absence through illness of Ron Leach, called for contributions from the floor. Those taking part were Norman Hitchcock, A. J. Goodfellow, E. Thornton, R. A. Fraser, and Miss M. C. Clarke. Put to the vote the motion was lost by a large majority.

Votes of thanks to the proposers and seconders by Jim Clark, and to the chairman by Wilfred Davies, were carried with such acclamation that there could be no doubt that everyone had had a good evening.

In addition to Debate, the London Branch function on 21 January also provided Dinner and Drinks as shown above

Kuwait Branch

On 21 December the Rt. Hon. Lord Geddes, President of the Institute, gave a most interesting and well-attended talk on "Modern Trends in Tanker Design" in the Kuwait Little Theatre. The chair was taken by D. S. Curtis, deputy chairman.

Lord Geddes traced the increase in size of the "average" tanker, and indicated that because of the change in recent years of the geographical pattern of refining there were now two types of tanker—the "Liner" and the "Tramp" types. Large numbers of the latter, capable of carrying a variety of cargoes to a wide range of ports, would always be required. The "Liner" tanker would largely be restricted to carrying very large cargoes of crude oil between producing areas and a relatively few major refining ports. These vessels would be up to 100,000 tons or possibly even larger. The "average" tanker of the future, he predicted, would be of about 65,000 tons, with the bridge aft, and powered by 30,000 h.p. steam turbines running on ordinary boiler fuel oil. As far as the Middle East was concerned he thought the volume of oil to be handled would warrant both pipelines and tankers making the Canal passage as well as the Cape passage. The minimum size of vessel economical on the latter run was of about 65,000 tons.

Lord Geddes touched on the possibility of nuclear-powered vessels, the submarine tanker, and the tanker trailer. An interesting development in tanker design was the liquefied-gas tanker. Trial consignments of liquefied gas were expected to arrive in the United Kingdom during 1958.

In reply to a question he said that single-screw vessels were more economical, more handy, and less liable to damage than those with twin screws.

An important point, often overlooked by the men at the shore end in the producing and refining areas, was the vast capital investment in tanker fleets.

The vote of thanks to Lord Geddes, proposed by J. M. Dougary, was heartily endorsed by the audience.

On 15 January E. D. Brockett, of Gulf Oil Corporation head office in Pittsburgh, gave a talk on the events leading up to the present weakening of the oil markets.

In August 1957 most producers in the States found themselves with brimming crude tankage. This was partly due to lack of restriction of allowables by the State Regulatory Bodies as the abnormal demand of the earlier part of the year decreased and partly to a rather poor natural domestic increase in consumption.

Thus, as wells in states where production was controlled were permitted to produce more than the pipeline companies could lift, purchaser proration had to be introduced though this measure was virtually non-existent now.

Later a U.S. governmental commission found that imported crude oil was influencing the situation and, as a

result, importers were requested to make a reduction in shipments, to which request most importers were adhering.

However, Mr Brockett continued, imminently, other foreign (to the U.S.) production was likely to influence the market. In 1957 when sales were held for concessions in Lake Maracaibo many "independents" invested heavily. Production from these concessions was about to commence. The oil produced must surely be sold in order to obtain some return on the investment. Such oil could further depress the market.

However, Mr Brockett was confident that the overall average world energy demand would continue to increase.

South-Eastern Branch

The topic at the meeting held on 3 December 1957 at the King's Head Hotel, Rochester was "Corrosion and Corrosion Prevention". The speaker was P. A. Raine, who introduced his subject briefly and then showed two excellent films entitled *Corrosion in Action.*

These films, produced by the International Nickel Company, showed both the mechanism of corrosion and some of its aspects, as well as touching on methods of cathodic protection. After the films Mr Raine amplified some of the points made, and answered members' questions. In addition, he explained the many exhibits that he had brought along to demonstrate the effects of different forms of corrosion attack on various metals.

The evening ended with a hearty vote of thanks to Mr Raine.

The Annual General Meeting of the Branch was held at the King's Head Hotel, Rochester on 7 January.

A. Chatting, in presenting the chairman's report for the year, said that although the number of Branch members had continued to rise, the overall membership numbers had fallen. In view of the heavy increase in postal charges, corporate members living on the fringes of the south-eastern area had been asked if they still wished to be included in the Branch's circulation list in spite of their great distance from the centre of meetings. Many of these members had indicated that they did not wish to put the Branch to this unnecessary trouble and expense, so their names had accordingly been removed from the list of Branch members. Turning to the review of the year's events, Mr Chatting mentioned the highly successful dinner-dance held at the Tudor House, Bearsted in November. This function set a new high standard and the Branch will make every effort to see that this standard is maintained and, if possible, excelled.

Among meetings held during the year was a joint meeting with the Kent Sub-Branch of the Royal Institute of Chemistry, when Dr S. F. Birch spoke on "Petrochemicals". The Branch broke new ground with a children's lecture and exhibition held at the Medway College of Technology during the Christmas holidays. Group Captain Douglas Bader was the speaker and various oil companies provided an exhibition to fit in with his topic of "Oil in the Air". Three summer visits had been arranged, including a week-day trip to the Esso refinery at Fawley.

The Treasurer, L. J. Challis, presented the balance sheet and drew attention to the continued improvement in the finances of the Branch. Prompt payment of subscriptions from an increased number of Branch members had resulted in the balance in hand rising during the year in spite of heavier expenditure on various aspects of the Branch's activities.

Committee members elected for the coming year were C. Billingsley, L. J. Challis, A. Chatting, D. K. Fraser, J. S. Manser, F. W. Martin, J. R. Moore, D. K. L. Morgan, and C. P. Williamson.

The meeting ended with a showing of the films *Foothold in Antarctica* and *Transatlantic Background.*

Scottish Branch

The Annual General Meeting was held in the North British Hotel, Edinburgh on 23 January.

J. M. Caldwell, J.P., chairman, presided and, after giving his Annual Report on the activities of the Branch for the previous year, thanked the honorary treasurer (Dr G. H. Smith), honorary recorder (Dr W. B. Peutherer), and honorary secretary (W. M. Stirling) for their services.

J. G. Annan and F. Cook were elected to the committee to fill vacancies created by the resignations of Dr H. B. Nisbet and R. Crichton. George Fleming and George Dewar were re-elected auditors.

N. W. Huskisson, training officer to BP Refinery (Grangemouth) Ltd spoke on the subject of "Staff Training". He first drew attention to the IP Symposium on Staff Training, held in London in January 1957, where papers by representatives of various oil companies gave an excellent picture of training efforts in the industry.

Mr Huskisson dealt with the training and education of managers, which he thought was the most important aspect of staff training, since the quality of training of managers determined largely the quality and quantity of all other training in industry.

He gave a brief account of present-day training of managers and pointed to post-war developments in education as they affected young people before they entered industry and afterwards, and mentioned the rate of technological advance that intensified the difficulties of management training.

He touched on the revival of what he termed the "arts or science graduates in management" controversy. Much could be said for both sides, but narrow specialization should be avoided. Industry would have to carry out much of the "balancing-up" of both types of graduate. But he stressed that both arts and science graduates needed humility more than ever to prevent widening of the gulf between those in the top ranks of industry and the rest.

Mr Huskisson answered a variety of questions, and on the call of the chairman, he was accorded a very cordial vote of thanks.

Bahrain Branch Second Annual Dinner

(Left to right): *P. R. A. Ensor, Mrs and D. C. Carden, G. Todd (assistant general manager, Qatar Petroleum Co.), Mrs and W. A. Schmidt*

(Left to right): *Mrs Cotter, A. H. R. Grimsey (then fields manager, Qatar Petroleum Co.) and Mrs Grimsey, W. H. Cotter*

The Second Annual Dinner of the Bahrain Branch of the Institute was held at Dukhan, Qatar, on 14 November 1957, the chair being taken by W. H. Cotter, chairman of the Branch. The guest of honour was D. C. Carden, British Political Agent in Qatar, and total attendance was 79 members and their wives and guests.

Replying to the toast "The Institute of Petroleum", proposed by D. C. Carden, the chairman first referred to

Chairman of the Bahrain Branch, W. H. Cotter, speaking at the Annual Dinner. Left to right are: Mrs A. H. R. Grimsey, D. C. Carden (Political Agent, Qatar), P. R. A. Ensor (general manager, Qatar Petroleum Co.), Mrs W. A. Schmidt, D. M. Brown (manager of Oil Operations, Aramco), and S. F. Ford (production superintendent, Basrah Petroleum Co.)

the formation of the Branch as a separate organization from the original Persian Gulf Branch. The Branch now had a membership of 107 corporate members and 13 branch members, thirty of whom came from Qatar. It was therefore fitting that when Herbert Grimsey, the fields manager in Qatar, suggested holding this dinner in Qatar, the invitation was accepted by the Branch Committee without hesitation. Mr Cotter said he particularly thanked P. R. A. Ensor for the hospitality which they had received from his Company and staff, and Eddie Sprange, the Qatar member of the Committee, for the time he had spent in making the arrangements for the visit.

Mr Cotter then briefly outlined the history of the Institute of Petroleum and referred to comments that the *Journal* tended to devote too much space to refining and lubrication research. The reply from London had been that, for the type of paper which they would like to see in the *Journal*, reliance had to be placed on the man in the field to produce such papers. It seemed, therefore, said Mr Cotter, that the fault might lie with themselves, but on the other hand there was difficulty in getting permission to publish such papers. He felt that there was more to be gained than lost in the Persian Gulf area by a free exchange of information such as had been achieved in the Kuwait Symposium on Reservoir Engineering Data.

Concluding, Mr Cotter paid a tribute to Herbert Grimsey, for his energetic endeavours on behalf of the Bahrain Branch and particularly for his work behind the scenes in Qatar. Mr Grimsey was being transferred to Basrah and might even start an IP Branch in Iraq. They wished him every success in his new post.

The toast "The Guests" was proposed by P. R. A. Ensor.

On the day prior to the dinner members and their wives from Saudi Arabia, Bahrain, Kuwait, and Iraq had travelled to Dukhan and had been welcomed by A. H. R. Grimsey, fields manager of Qatar Petroleum Company, and his wife at a reception in their bungalow.

On the day of the dinner a symposium on "Operations of the Qatar Petroleum Company Ltd and Associated Companies" had been held. The speakers were members of management and senior staff and the subjects discussed were drilling, petroleum engineering, production, engineering and general services, and terminal services.

Essex Branch Dinner-Dance

The first Annual Dinner-Dance of the IP Essex Branch, held at the Shell Club, Corringham, on 18 January was a huge success. Nearly two hundred members, guests, and their ladies were present, the official guests including Lieut-Colonel S. J. M. Auld, O.B.E., M.C., D.Sc., (a past-president of the Institute), J. Paul (a director of Mobil Oil Co. Ltd) and Mrs Paul, Lester Horne (a director of Charrington, Gardner, & Lockett Ltd) and Mrs Horne, D. A. Hough (IP general secretary) and Mrs Hough, and George Sell (IP editor) and Mrs Sell. The dinner was presided over by D. H. Tullis, Branch chairman, and he was supported by members of the Branch Committee.

The toast "The Institute of Petroleum" was proposed by B. R. Fraser, refinery manager at Coryton, who said that the usefulness of the Branch was two-fold. First, it gave a lead in the matter of general education in regard to the petroleum industry, and secondly it enabled the individual member, and particularly the non-corporate member, to meet more people in the industry and thus to learn more about the industry and its operations.

The Institute, said Mr Fraser, also performed a great service to the industry by bringing together firms and individuals in a friendly atmosphere. That was well evidenced that evening when they saw gathered together men from Mobil, from Shell, from London and Thames Haven Oil Wharves, from Charringtons, and so on, while the most excellent arrangements for their entertainment

Some of the Essex Branch Committee at the Dinner-Dance. L. T. Hogg (hon. treasurer), Mrs and Dave Tullis (chairman), Mrs and T. Latta (committee member), and E. G. Hannah (hon. secretary)

Also at the Essex Branch Dinner-Dance were: B. R. Fraser (refinery manager, Coryton), Lester Horne (director of Charrington, Gardner, Locket & Co. Ltd), J. A. Paul (director of Mobil Oil Co.) and H. L. Fountain (installation manager, London and Thames Haven Oil Wharves Ltd)

Whether sitting out or dancing, the Essex Branch first Dinner-Dance was a function thoroughly enjoyed by all present

Dave Tullis (right), *Essex Branch chairman, and Mrs Tullis, with Col. S. J. M. Auld, a past president of the IP—at the Essex Branch Dinner-Dance*

had been made by D. Rawlinson, Shell; E. Murray, Mobil; and E. G. Hannah of London & Thames Haven Oil Wharves. They were not meeting under the emblem of any one company but under the IP emblem—the archeopteryx. He reminded his audience that the ever-decreasing circles in which this bird is reputed to have flown were not to be confused with the five concentric circles which surrounded the IP monogram. The latter represented the five main spheres of activity of the petroleum industry—geology, production, transportation, refining, and marketing.

Lt.-Col. S. J. M. Auld, acknowledging the toast, congratulated the Branch on having made its dinner-dance its main social function. By doing so they had provided an opportunity for the ladies to be brought in to play their part in making a success of things.

Wishing the Branch continued success, Colonel Auld said that it had a grand tradition as a background. Essex was a county which inspired deep affection. It was from Essex that the Angles and Saxons had set out to rule the world—and they still ruled it!

H. L. Fountain, proposing the toast "The Guests" extended a welcome not only to the official guests but also to the wives and private guests of members. It was particularly pleasing to see so many ladies present and he hoped that they would enjoy the rest of the proceedings.

A witty reply from Lester Horne concluded the formal part of the function and after a short interval while the dining tables were cleared, dancing was the order until midnight.

South Wales Branch

The fourth meeting of the session was held on 19 December 1957 at the Training Centre, BP Refinery (Llandarcy) Ltd, with Dr L. S. Thornes in the chair.

A paper on "The Angle Bay Project" was presented by J. F. L. Grocott, A.R.T.C. (Salf), M.Inst.H. & V. Eng.

Slides of the Milford Haven areas involved in the scheme were shown together with an artist's impression of the finished project. Mr Grocott said that Milford Haven was chosen for three reasons:—

(1) The increasing size of tankers.

(2) The inability of the Port of Swansea to handle the larger tankers.

(3) The deep-water facilities offered by Milford Haven.

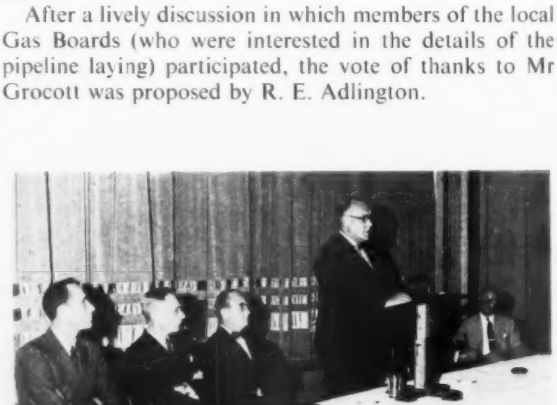
As early as 1948 serious consideration was given to the fact that 32,000-ton tankers could not enter the Port of Swansea, even with modification. In the last 10 years tanker sizes had grown rapidly from the 12,000/16,000 tonners, through the one-time "giant" 28,000 tonners, to the 40,000 tonner and now the 60,000 and 80,000 tonners, with 100,000 tonners on the drawing boards.

The Angle Bay Project was designed to handle tankers up to 100,000 tons.

Mr Grocott discussed the need for, and the work entailed in obtaining, a Parliamentary Bill with its aspects of public protection on the one hand and the right of compulsory purchase or wayleave on the other. The Bill was a necessary implement in view of the many interests involved, such as County, Rural, and Urban authorities, landlords, and private individuals. An important factor in the planning of the pipeline route was direct contact with the interested parties to obviate petitions and resolve difficulties.

The installation at Popton Point would consist of a two-berth jetty connected by a shore arm approximately 1250 ft long to an administrative and service terminal in Popton Fort. Transfer pipelines from the berths would pass to storage tanks about 1½ miles from the terminal. From the tanks an 18-inch pipe would carry the crude oil to the BP refinery at Llandarcy, about 60 miles to the east.

After a lively discussion in which members of the local Gas Boards (who were interested in the details of the pipeline laying) participated, the vote of thanks to Mr Grocott was proposed by R. E. Adlington.



As recorded in the February issue, Lord Geddes, President of the IP, recently addressed the Bahrain Branch. Above he is seen delivering his address. With him are Rod Smith, Neville Pocock, W. H. Cotter (*Branch chairman*) *and* (right) *George Beeby Thompson* (*immediate past-chairman*)

Notes of the Month

U.S Petroleum Production Increases in 1957

The annual U.S. Bureau of Mines preliminary report for the year estimates that petroleum production in the United States rose by 2000 b.d. in 1957, compared with the output for 1956. Total 1957 production is given as 7153 thousand b.d.

The value of crude petroleum at the well, averaged at $2·77 a barrel in 1956, increased to an estimated $3·10 a barrel last year. This was the first material change in average wellhead value since 1954.

Total crude output for 1957 was 2611 million barrels, valued at the wellhead at $8094 million, compared with $7263 million in 1956. Production in the first quarter of 1957 was raised to offset the foreign-supply restriction caused by the closure of the Suez Canal. After re-opening of the canal in April, stocks by mid-year had regained a high level, imports had increased, and production had been cut back. Despite a voluntary programme of curtailing imports of foreign crude, domestic production remained low during the second half of the year.

Natural gasoline production and value are estimated to have been unchanged at 138 million barrels and $430 million in 1957. LPG production increased slightly from 154 million barrels in 1956 to 157 million barrels last year, and its average value also showed a small increase.

Marketed production of natural gas continued its steady increase, reaching an estimated 10,688 thousand million cubic feet. The average wellhead value also continued upward, averaging 11·2 cents/1000 cu. ft, against 10·8 cents/1000 cu. ft in 1956.

New Danish Tanker Company

One of BP's Danish associates, A/S Tanskibsrederiet (Tank Shipping Co. Ltd), has entered into a tanker-owning partnership with the East Asiatic Co., a Danish company well known for its ship-owning and world-wide trading interests.

The partnership will acquire two 35,000 dw ton tankers which are being built in the United Kingdom and are due for delivery in December 1958 and January 1959. The tankers will be registered in Denmark and used in BP service. They will be managed by the East Asiatic Co. on behalf of the partnership, which is to be named Nordic Tankships I/S.

More Oil Found in the Midlands

Continuing the search for more oil in the United Kingdom, BP Exploration Company has had two recent successes in the Midlands. At Langar and Bothamsall in Nottinghamshire initial test wells have found oil. Further drilling will be needed to determine the extent of these discoveries, but first results raise hopes that they indicate new oil deposits of commercial significance.

Both these wells are relatively near existing oilfields. Langar is some 3 miles west of Plungar, discovered in 1953, and Bothamsall is 5 miles north-west of Egmanton, discovered in 1955.

Total production of crude oil in 1957 from existing BP oil fields in Britain—Eakring and Egmanton (Notts), Plungar (Leics), and Formby (Lancs), was some 82,000 tons.

Fifth Esso Supertanker Launched

The first supertanker to be launched for the Esso Company in 1958 and the fifth of eighteen supertankers under construction or on order and all exceeding 36,000 dw tons, *Esso Bristol* took the water from the Hamburg yard of Howaldswerke Hamburge AG at the beginning of February.

She was named by Mrs Chilvers, wife of C. Chilvers, a director of Esso Petroleum Co. Ltd, and honorary secretary of the Institute.

Like her sister ships, *Esso Bristol* has a length of 690 ft, a beam of 90 ft, and a loaded summer draught of 35½ ft. Her service speed will be 17 knots and she is expected to be delivered at the end of July this year.

First Electro-Hydraulic Control Refinery on Stream

Complete electronic instrumentation is featured on three new refinery units which went on stream recently at the plant of Regent Refining (Canada) Ltd at Port Credit, Ontario.

They are claimed to be the first refining units in the world designed to operate without employing air in any phase of instrument control. Instead, electro-hydraulic valves are actuated by electrical signals from control instruments which receive signals characteristic of changes in temperature, pressure, or flow.

Elimination of air is an important factor in cold climates where freeze-ups in pneumatic lines are a constant threat to continued efficient operation of units. The new installation eliminates this type of trouble.

The electronic instrumentation has been installed on a Universal Oil Products fluid catalytic cracking unit, a UOP polymerization unit, and gas concentration facilities. Their start-up marked completion of one of the first steps in an extensive expansion and modernization programme being carried out by Regent.

New Tanker Terminal Plan for Milford Docks

At the end of January Gel Tankers Ltd made an offer for a long-term lease of the Milford Dock Company's site, as the first step in making Milford Docks an independent and fully integrated oil terminal capable of handling 68,000-ton tankers.

E. A. E. Nichols-Roth, managing director of Gel Tankers, has announced that his company wishes also to provide dry-docking facilities and fuel-oil storage tanks at the site.

Under the new name of Associated Tankers and Terminals, Gel Tankers intend shortly to make a public issue of £4·3 million in ordinary and convertible debenture stock.

International Tankers (Bahamas) Ltd, which will be a subsidiary of the new company, is building 68,000-ton tankers, the first of which, the s.s. *New Providence*, is expected to be delivered in December next year. A 15-year time charter for her has already been placed.

New Deep Test Well in North Africa

The D'Arcy Exploration Co. (Africa) Ltd, a BP subsidiary company, has begun drilling its first deep test well in Libya. Situated about 30 miles south of Tripoli, the well, known as Castel Benito No. 1, has reached 415 ft.

This first test well follows several years of survey work in Libya by the Company, which has concession areas in all three provinces, Tripolitania, Cyrenaica, and the Fezzan.

World's Northernmost Refinery on Stream

Finland's first oil refinery, Neste Oy

Neste Oy, Finland's first petroleum refinery, is now on stream and operating at 115 per cent of capacity.

The refinery, which will meet about half Finland's demand for petroleum products, was designed and engineered by The Lummus Company of New York and its European subsidiaries in Paris and The Hague.

The firm of Neste Oy is controlled by the Finnish Government. The refinery is located at Naantali, near the south-western port of Turku, and is designed to handle a mixture of 18,500 b.d. of Middle East and Russian crudes or 19,200 b.d. of Russian crude alone.

The refinery includes an electrical desalting unit, an atmospheric and vacuum distillation unit, an Atlantic catalytic reforming unit (Cat-former) with a total charge of 3400 b.d., a Socony Mobil Thermofor catalytic cracking unit with a fresh feed charge of 6000 b.d., a California Research Corporation catalytic polymerization unit to produce 500 b.d. of polymer gasoline, and an asphalt vacuum and oxidation unit to produce 1300 b.d. of paving-grade asphalt. There are also units for vapour recovery, solid copper chloride sweetening, and double caustic and inhibitor treating.

It is claimed that Neste Oy is the first complete refinery in Europe to have a fully electronic instrument control system. The refinery was completed in less than 24 months from the date when procurement areas were first definitely established.

Crude oil was first introduced to the atmospheric unit towards the end of July last. Six weeks after the start-up the refinery was up to capacity, producing a full line of gasoline, fuel oil, LPG, and asphalt products.

The Lummus Company provided detailed engineering, co-ordination of all procurement, construction supervision, and extensive assistance during initial operation. Lummus also provided assistance in arranging for a broad financing scheme, set up an operator training school at the job site, and helped to set up the overall refinery organization and manpower requirements.

Since the refinery was constructed on a virgin tract of ground, complete auxiliary and offsite facilities had to be provided. They include sea-water pumping stations for cooling and fire-fighting use, compressor stations for instruments and plant air, and outdoor-type steam boilers with feed-water treating.

Tankage for approximately 30 days' storage of crude and finished products, and facilities for railway, road vehicles, and tanker or barge shipment of the products has been provided. Other facilities include plant for addition and blending of TEL, inhibitors, dyes, deactivators, etc., as required for distillate products.

The refinery has its own fire-station, fire-fighting equipment, and fire brigade. There are also a warehouse and workshop, a laboratory for plant control and research, and a modern administration building that contains a canteen.

The supply of material and erection were handled by a French group headed by Fives-Lille and the Mannesmann organization in Germany.

New Bulk Oil Installation in Malta

BP's newest bulk oil installation, on the island of Malta, was officially opened in mid-December. For several years BP has maintained a small depot on Malta, which is augmented by the new installation which is on a headland overlooking St Paul's Bay, 12 miles north of Valetta.

The new installation is supplied by tanker, products being pumped ashore through a submarine pipeline. The first vessels to use this, were *British Pioneer* and *British Warrior*, the first carrying aviation gasoline and the latter motor spirit, kerosine, and gas oil. Products from the installation are distributed throughout the island by road tankers.

CPR Incorporate New Subsidiary

Canadian Pacific Railway Company has recently incorporated Canadian Pacific Oil and Gas Ltd as a wholly-owned subsidiary company.

This will allow CPR to take fullest advantage of opportunities to develop its mineral resources located in approximately 11·3 million acres of land in the Prairie provinces.

Canadian Pacific Oil and Gas Ltd has power to engage in all phases of the discovery, development, operation, and sale of oil, gas, and other mineral resources and their products.

Petroleum Trade of the United Kingdom in 1957

Total imports into the United Kindom of petroleum and its liquid products during 1957 were, according to the preliminary returns*, 10,118 million gallons, an increase of 2·3 per cent over the total for the preceding year. Details for individual products are set out in Table I and it will be noted that of the total quantity, 7254 million gallons, was crude petroleum plus a small quantity of refinery fuel. By reference to Table II it will be seen that on a percentage basis, the crude oil import in 1957 was lower than in 1956 which in turn was below the percentage for 1955. This was no doubt due to the closure of the Suez Canal during the latter months of 1956 and the earlier months of 1957.

The Suez Canal factor would also seem to be responsible for the corresponding increases in import of motor spirit and fuel oil in particular.

Values of Imports

In regard to cif values of oils imported into the U.K. Table III shows that for crude and every product except "other spirit" there were increases in comparison with 1956. These increases varied from 6·2 per cent for motor spirit to 24·3 per cent for fuel oil. In the case of crude petroleum the percentage increase was 17·9. Other increases were gas oil 16·6 per cent; kerosine and lubricating oil 12·1 per cent; diesel oil 11·7 per cent; and "other" crudes 10·7 per cent.

Consigning Countries

In the list of countries of consignment, which are not necessarily the countries from which the import originated, there are some interesting changes. The data for individual countries is set out in Table IV but the overall effect of the Suez affair is best seen in Table V. Here it is seen that the percentage of U.K. oil imports from the Middle East dropped from 64·0 per cent in 1956 to 53·1 per cent in 1957. To make up this deficiency in U.K. requirements it was necessary in the early part of 1957 to seek crude petroleum and products elsewhere and it was mainly the United States and the Caribbean area which supplied the oil to fill the gap. Thus, Table V shows that the percentage from the United States increased from 4.9 in 1956 to 11·3 in 1957 and from the Caribbean from 20·8 to 26·2.

Re-Exports of Imports

Comparatively small quantities of the products imported into the U.K. are re-exported and details are shown in Table VI.

*Trade and Navigation of the United Kingdom, December 1957. HMSO, 17s 6d net.

TABLE I

QUANTITY AND VALUE OF U.K. PETROLEUM IMPORTS

	1957		1956		1955	
	Quantity 1000 *gal*	*Value* £	*Quantity* 1000 *gal*	*Value* £	*Quantity* 1000 *gal*	*Value* £
Crude petroleum:						
Full and topped crudes	6,951,438	265,151,677	7,034,834	227,518,311	6,833,913	208,234,523
Other*	302,753	15,425,719	374,653	17,241,113	380,232	15,690,517
	7,254,191	280,577,396	7,409,487	244,759,424	7,214,145	223,925,040
Refined petroleum:						
Motor spirit†	741,049	46,085,493	622,492	36,459,242	560,544	31,527,262
Other spirit	79,042	4,970,555	45,585	2,920,189	33,334	2,268,143
Kerosine	414,005	22,350,248	385,248	18,552,035	426,012	19,629,588
Gas oil	560,734	30,553,008	513,796	23,994,547	506,525	23,059,467
Diesel oil	47,023	2,313,985	62,703	2,752,724	59,150	2,528,264
Fuel oil	922,133	36,498,362	739,570	23,561,217	562,839	16,524,224
Lubricating and other heavy oils	100,229	10,973,154	114,157	11,147,728	110,554	8,866,517
Total	10,118,406	434,322,201	9,893,038	364,147,106	9,473,103	328,328,505
	Cwt		*Cwt*		*Cwt*	
Petrolatum	166,356	582,332	186,487	622,950	222,127	652,808
Waxes:						
Paraffin wax	669,957	2,341,487	672,958	2,330,776	752,343	2,628,197
Other petroleum wax	141,419	744,287	166,557	845,589	152,684	715,208
All other refined petroleum products, not elsewhere specified, and pitch (excluding natural asphalt and bitumen)	—	2,855,923	—	2,458,530	—	2,018,526
Total	—	£440,846,230	—	£370,404,951	—	£334,343,244

*Includes refinery feed but excludes unfinished oils for blending.
†Including blending components.

TABLE II
PERCENTAGE IMPORTS OF PETROLEUM INTO THE U.K.

	1957	1956	1955
	Per cent		
Crude petroleum	71·7	74·9	76·2
Motor spirit	7·3	6·3	5·9
Other spirit	0·8	0·5	0·4
Kerosine	4·1	3·9	4·5
Gas oil	5·5	5·2	5·3
Diesel oil	0·5	0·6	0·6
Fuel oil	9·1	7·5	5·9
Lubricating oil	1·0	1·1	1·2
	100·0	100·0	100·0

TABLE III
AVERAGE CIF UNIT VALUES OF U.K. PETROLEUM IMPORTS

	1957	1956	1955
	£ *per* 1000 *gal*		
Full and topped crude ...	38·13	32·34	30·47
Other crudes	50·95	46·02	41·26
Motor spirit	62·19	58·57	56·24
Other spirit	62·88	64·06	68·07
Kerosine	53·98	48·16	46·08
Gas oil	54·49	46·70	45·52
Diesel oil	49·19	43·90	42·74
Fuel oil	39·58	31·85	29·36
Lubricating oil	109·49	97·65	80·20
	£ *per cwt*		
Petrolatum	3·50	3·34	3·04
Paraffin wax	3·49	3·46	3·49
Other petroleum wax ...	5·26	5·07	4·68

TABLE IV
COUNTRIES CONSIGNING PETROLEUM TO THE U.K.

Country and product	*Thousand gallons*		
	1957	1956	1955
KUWAIT:			
Crude petroleum	3,635,839	3,779,162	4,202,231
VENEZUELA:			
Crude petroleum	1,349,434	713,538	615,788
Kerosine	67,559	60,166	62,888
Gas, diesel, and fuel oils	158,509	126,109	156,288
Lubricating oil	14,316	20,883	13,242
	1,589,818	920,696	848,206
UNITED STATES OF AMERICA:			
Crude petroleum	490,812	137,430	16,251
Motor spirit	133,488	63,155	53,863
Kerosine	22,235	10,938	10,283
Gas, diesel, and fuel oils	458,966	218,479	204,555
Lubricating oil	41,880	54,674	60,626
	1,147,381	484,676	345,578
IRAN:			
Crude petroleum	626,500	818,759	321,348
Motor spirit	66,735	33,287	16,004
	693,235	852,046	337,352
NETHERLANDS ANTILLES:			
Crude petroleum	119,544	232,629	246,526
Motor spirit	79,640	70,647	123,433
Kerosine	113,332	121,492	174,016
Gas, diesel, and fuel oils	218,757	198,047	177,832
Lubricating oil	22,544	22,575	18,175
	553,817	645,390	739,982
NETHERLANDS:			
Crude petroleum	78,821	81,061	93,826
Motor spirit	67,995	82,678	74,892
Kerosine	77,698	42,515	32,296
Gas, diesel, and fuel oils	198,842	322,824	219,114
Lubricating oil	11,232	6,284	4,887
	434,588	535,362	425,015
BAHRAIN, QATAR, AND TRUCIAL STATES:			
Crude petroleum	306,294	553,473	428,672
Motor spirit	63,918	86,258	66,146
Kerosine	16,631	31,696	26,924
Gas, diesel, and fuel oils	33,028	79,135	51,294
	419,871	750,562	573,036
TRINIDAD:			
Crude petroleum	23,410	3,122	6,707
Motor spirit	137,692	155,859	134,278
Kerosine	60,550	58,093	62,442
Gas, diesel, and fuel oils	186,393	214,468	170,603
	408,045	431,542	374,030
IRAQ:			
Crude petroleum	296,742	714,073	1,005,719
SAUDI ARABIA:			
Crude petroleum	163,244	151,167	90,457
Gas, diesel, and fuel oils	—	—	6,379
	163,244	151,167	96,836
ADEN:			
Motor spirit	123,013	51,030	31,646
Kerosine	35,918	31,484	28,451
	158,931	82,514	60,097
COLOMBIA:			
Crude petroleum	71,206	23,832	50,022
SARAWAK:			
Crude petroleum	60,789	150,177	96,548
ITALY:			
Motor spirit	7,720	34,250	22,195
Gas, diesel, and fuel oils	35,658	36,661	22,243
	43,378	70,911	44,438
FRANCE:			
Motor spirit	10,743	26,918	26,591
Kerosine	1,757	7,614	17,968
Gas, diesel, and fuel oils	21,905	67,521	90,495
Lubricating oil	2,152	3,717	6,758
	36,557	105,770	141,812
PERU:			
Crude petroleum	31,555	40,321	30,724
SOVIET UNION:			
Lubricating oil	6,944	3,818	—
INDONESIA:			
Crude petroleum	—	2,499	3,286
WESTERN GERMANY:			
Gas, diesel, and fuel oils	36	2,940	8,985

TABLE IV

COUNTRIES CONSIGNING PETROLEUM TO THE U.K.—(CONTD.)

Country and product	*Thousand gallons*		
	1957	1956	1955
OTHER COMMONWEALTH COUNTRIES AND IRISH REPUBLIC:			
Crude petroleum	—	8,228	1,716
Motor spirit	2,064	1,765	2,178
Kerosine	415	121	261
Gas, diesel, and fuel oils	54,290	17,181	10,736
Lubricating oil	565	427	422
	57,334	27,722	15,313
OTHER FOREIGN COUNTRIES:			
Crude petroleum	1	16	4,244
Motor spirit	48,041	16,645	9,318
Kerosine	17,910	21,129	10,483
Gas, diesel, and fuel oils	163,506	32,704	9,990
Lubricating oil	596	1,779	1,640
	230,054	72,273	35,675

Bunker Oils

Oil fuel taken on board vessels engaged in the foreign trade and by fishing vessels totalled 823,908,000 gallons in 1957, compared with 1,051,313,000 in 1956. Of these amounts, the quantities placed on vessels under the British flag were 567,536,000 gallons in 1957 and 735,625,000 gallons in the previous year.

Exports of Home Manufactures

As will be seen from Table VII, which details the quantities of home-produced oil produce exported from the U.K., there was a decline of 16·9 per cent in the quantity and of 9·4 per cent in value. The major reduction in quantity was in relation to gas oil, the export of which was nearly halved.

Average unit values of these exports in £ per 1000 gallons, were: motor spirit, £58·9 (£54·2 in 1956), other spirit, £112·9 (£106·1); kerosine, £50·5 (£48·1); gas oil, £48·6 (£43·8); diesel oil, £43·2 (£42·4); fuel oil, £32·1 (£31·2); lubricating oil, £184·4 (£175·8); and, in £ per cwt, lubricating greases £4·5 (£3·9); and, £ per ton, bituminous asphalts, £25·6 (£23); pitch, £11·3 (£10·8).

TABLE V

U.K. PETROLEUM IMPORTS BY ZONES OF CONSIGNMENT

	1957		1956		1955	
	Mil. gal	*% of total*	*Mil. gal*	*% of total*	*Mil. gal*	*% of total*
Middle East	5368	53·1	6330	64·0	5872	62·0
Caribbean and Peru	2654	26·2	2062	20·8	1993	21·0
Europe	521	5·2	719	7·3	602	6·3
United States ...	1147	11·3	485	4·9	346	3·6
Far East	61	0·6	152	1·5	100	1·1
Undisclosed areas ...	366	3·6	145	1·5	561	6·0

TABLE VI

U.K. RE-EXPORTS OF IMPORTED PETROLEUM

	1957	1956	1955
	Thousand gallons		
Motor spirit	28,827	18,748	11,895
Gas, diesel, and fuel oils ...	14,735	65,347	38,076

TABLE VII

U.K. EXPORTS OF HOME-PRODUCED AND HOME-MANUFACTURED PETROLEUM

Product	1957		1956		1955	
	Quantity 1000 *gal*	*Value* £	*Quantity* 1000 *gal*	*Value* £	*Quantity* 1000 *gal*	*Value* £
Motor spirit	449,147	26,489,124	443,346	24,014,329	396,919	21,023,789
Other spirit	4,759	537,334	4,744	503,231	4,618	465,161
Kerosine	59,952	3,027,493	57,600	2,768,631	55,828	2,639,030
Gas oil	209,442	10,181,176	401,519	17,598,842	239,298	10,289,412
Diesel oil	100,575	4,343,906	119,435	5,069,705	103,482	4,198,219
Fuel oil	646,346	20,759,354	755,757	23,591,909	665,312	18,674,977
Lubricating oil	95,179	17,552,429	102,224	17,971,307	85,321	13,609,489
Total	1,565,400	£82,890,816	1,884,625	£91,517,954	1,550,778	£70,900,077
	Cwt		*Cwt*		*Cwt*	
Lubricating greases and compounds (including cable impregnating compounds)	585,526	2,632,350	565,526	2,190,863	459,389	1,782,601
	Tons		*Tons*		*Tons*	
Bituminous asphalts (manufactured) and emulsions (other than for use as paint) ...	71,563	1,831,907	83,432	1,923,501	74,116	1,674,866
Pitch (other than natural asphalt and bitumen)	235,491	2,669,506	267,217	2,876,114	226,534	2,353,951
All other refined petroleum products, not elsewhere specified, and crude petroleum ...	—	868,546	—	1,007,344	—	790,547
Total	—	£90,893,125	—	£99,515,776	—	£77,502,042

Personal Notes

Leonard Astley-Bell, president of Shell Caribbean Petroleum Co., New York, has been appointed general representative of the Royal Dutch/Shell Group's operations in Indonesia, in succession to B. Scheffer.

Mr Astley-Bell joined the group in 1930, and worked in the United States until 1935, in Mexico from 1936 to 1938 as director of the Mexican Eagle Oil Company, and in London from 1939 to 1946 as manager of Trade Relations Department of the Shell Petroleum Company. From 1947 until his current appointment in the United States he was executive vice-president, and later president of the Shell Caribbean Petroleum Co.

J. W. S. Straughan, chief engineer superintendent of BP Tanker Company, has retired after nearly 41 years with the Company.

He joined BP Tanker Company (then named British Tanker Company) as third engineer in May 1917 and was appointed chief engineer in 1919. In 1936 he was transferred to shore duties, and was appointed an engineer superintendent in 1937 and was promoted to chief engineer superintendent in 1955.

J. W. S. Straughan

As a result of the Company's fleet expansion, the marine engineering organization has been divided into two separate departments. From 1 February **J. Henderson** has been appointed chief engineer superintendent (Fleet Maintenance) and **E. H. W. Platt**, chief engineer superintendent (New Construction).

Mr Henderson joined the Company's sea-going staff in 1926 and attained the rank of chief engineer in 1941. He has served ashore as an engineer superintendent both overseas and in Britain since 1943.

Mr Platt, on retiring from the Royal Navy, joined the Company's head office in 1957.

J. Henderson

E. H. W. Platt

Dr John B. Hanson-Lowe, a geologist who joined the Shell Petroleum Co. Ltd in 1938, has travelled to most parts of the world during the past 20 years.

His first assignment was in Holland where he studied photogeology. From there he went to New Zealand and Australia where he served for 3 years before enlisting in the Royal Australian Air Force.

Dr J. B. Hanson-Lowe

His first post-war journey for the Company was to Egypt, and he also visited British Somaliland and Sinai. In 1949 he was awarded his doctorate for a series of studies on the geomorphology and climatology of central China and south-east Tibet.

On completion of his work in Europe he was transferred to British Borneo where he spent 3½ years. The Western Hemisphere next claimed him and for 2 years he was engaged on exploratory work in Canada.

After leave in Britain Dr Hanson-Lowe is now in Pakistan on another mission for the Company!

J. W. MacMahon, M.Inst.Pet., has been appointed general manager of the Industrial Lubricants Division of Wakefield-Dick Industrial Oils Ltd, in succession to **R. J. Turner**, M.Inst.Pet, who has retired. He has also been appointed to the Board of directors.

Mr MacMahon joined the Company in 1925, and worked in the Export Department from 1927 to the outbreak of the war.

On leaving the forces he returned to the Industrial Oils Department as a technical representative in the Midlands and was promoted sales manager in 1951, a position he retained later with Wakefield-Dick Industrial Oils Ltd.

The Company also announced the following appointments:—

C. R. Woodfield, works production manager for the Wakefield Group, has joined the Board of Wakefield-Dick.

New field staff appointments are:—

C. W. Page, D. S. Kirkpatrick, F. Rogerson, and **H. B. Towle**, as regional sales managers, and **M. Nicol** as regional sales promotion manager.

J. E. Cook, T.D., M.Inst.Pet., has been appointed manager of their Midland Region by Petrofina (Gt Britain) Ltd.

His previous post as manager of the North East Region has been filled by **L. H. McMillan**, previously deputy manager of that region.

Robert Weir has been elected chairman of BP Australia Ltd in succession to Leonard Darling who resigned at the end of December last on account of ill health.

Mr Weir has been a director of BP Australia Ltd since 1951.

M. A. L. Banks

M. A. L. Banks, B.Sc., F.R.I.C., M.I.Chem.E., F.Inst.Pet., general manager of the British Petroleum Company's Refineries and Technical Department, has been appointed a director of BP Trading Ltd (the Company's principal trading subsidiary) from 1 February in succession to **C. E. Spearing,** M.A., F.R.I.C., A.C.C.F.C., F.Inst.Pet., who recently retired.

R. Brewster Jennings, chairman of the board of directors of Socony Mobil Oil Company Inc., and chief executive officer of the Company, has retired.

He has been succeeded as chief executive officer by **Albert L. Nickerson,** president of Socony Mobil since 1955.

Mr Nickerson joined the company shortly after graduation from Harvard in 1933 and spent his first 3 years as a service station attendant and manager. He was then selected for management training and advanced through a series of marketing department executive posts until he joined the board of directors in 1946. In 1945 and 1946 he was in London as a director of Vacuum Oil Co. Ltd (now Mobil Oil Co. Ltd). On 1 January 1946 he was appointed chairman of Vacuum Oil Co. Ltd.

Fred W. Bartlett has succeeded Mr Jennings as chairman of the board of directors. He has been a director since 1953 and vice-president for production since May 1957.

Hugh H. Baird has resigned his directorships of Baird & Tatlock (London) Ltd and Hopkin & Williams Ltd, and recently sailed to Australia with his family on the *Orontes*. His long-standing interest in boats and experience as a yachtsman will find new applications in Australia, where he intends to build plastic hulls for small marine craft of all kinds.

B. W. Jesser

B. W. Jesser has been appointed manager of Kellogg International Corporation, London, to succeed F. E. Johnson who has become an assistant engineering vice-president of M. W. Kellogg

Mr Jesser was a contract operations staff engineer and was formerly manager of Kellogg's Design Engineering Department. He has been with the Company since 1942. Prior to this he was an instructor in chemical engineering at Princeton University, and has also served with DuPont.

James M. Carry has been elected vice-president and assistant to the president of The M. W. Kellogg Company, New York, a subsidiary of Pullman Incorporated.

Mr Carry will be in charge of the Personnel, Financial, Advertising, and Public Relations Departments. He will also be responsible for the co-ordination of budgeting and forecasting of all departments of M. W. Kellogg and its subsidiaries, and the co-ordination of the Fabricated Products Department manufacturing and sales.

He joined the Company in 1954 as assistant to the president, following three years as assistant to the president of Pullman Inc., Chicago. Prior to that he was a vice-president of the Pullman Company.

James M. Carry

Dr R. S. Silver has been appointed general manager of the Technical Division of G. & J. Weir of Glasgow.

Dr Silver was head of Weir's Research Department from 1939 to 1946. Before returning to the Company in 1956, he gained considerable experience in the fields of steam and combustion engineering where he held responsible appointments in design and development.

In 1945 he was awarded his D.Sc. for a thesis on "Saturated Liquid Vapour Mixtures in Steam Engineering". His paper on "Circulation in Water-Tube Boilers" to the Institution Mechanical Engineers was awarded a George Stephenson prize.

ESSO APPOINTMENTS

The following appointments, effective from 1 January, have been made by the Esso Petroleum Co. Ltd.

R. A. Marden, formerly comptroller, has been appointed tax adviser in charge of a new Tax Department. He will be responsible for handling matters relating to tax administration for the Esso Group in the U.K.

He joined the Company in 1935 as deputy accountant (head office), was promoted chief accountant in 1944, and became comptroller in 1949.

L. R. Pincott, deputy comptroller since 1953, has succeeded Mr Marden as comptroller. Mr Pincott joined the Company in 1950 as assistant accountant (head office).

C. A. Walder, A.M.Inst.Pet., manager, Supply Department since 1954, has been promoted to deputy general manager (Marine). He joined the Company in 1942 as assistant accountant and in 1952 was appointed assistant manager, Supplies and Shipping Department.

E. Chapman, A.M.Inst.Pet., formerly assistant manager, Supply Department has succeeded Mr Walder as manager. He joined the Company in 1930 and became assistant manager Supplies and Shipping Department, in 1952.

R. J. Kingsnorth has been appointed manager of the Process Control Division of Elliott Brothers (London) Ltd, a member of the Elliott-Automation Group.

Mr Kingsnorth has been connected with the electrical instrument industry for over 25 years, and for the past 17 years has been manager of the Erith instrument factory of Salford Electrical Instruments Ltd.

U.K CUSTOMS AND EXCISE RECEIPTS FROM PETROLEUM

In their report for the year ended 31 March 1957 the Commissioners of H.M. Customs and Excise state, in regard to hydrocarbon oils, that the trend of consumption was obscured by restrictions on supply. In the first half of the year consumption of light oils was 1 per cent higher than in the previous year and that of derv fuel was 10 per cent higher. For the whole year light oil consumption, due to rationing, fell by 6·5 per cent but derv consumption rose by 6 per cent. The expansion in the use of derv in goods vehicles, as noted in the previous report, continued.

Clearances of indigenous hydrocarbon oils dropped from 156·7 million gallons in 1955-56 to 143·4 million in 1956-57.

The Customs and Excise duties on light oils and derv fuel were increased from 2s 6d to 3s 6d per gallon from 6 p.m. on 4 December 1956 to restore the revenue that would have been lost on account of restrictions of supplies due to the closing of the Suez canal. The higher rate remained until shortly after the closing of the financial year.

The total revenue of £337·9 million was not far short of the 1956 Budget estimate of £340 million.

Details extracted from the report are as follows:

	1955–56		1956–57	
	Quantity retained for consumption gallons	*Net receipts* £	*Quantity retained for consumption gallons*	*Net receipts* £
Light Oils:		IMPORTED OILS		
Petroleum spirit—				
Motor spirit ...	2,054,729,240	256,840,302	1,912,998,815	260,513,238
Other spirit ...	46,856,521	5,857,077	47,069,356	6,658,637
Coal tar products—				
Benzole	136,203	17,025	44,180	6,540
Other sorts ...	1,455,440	181,929	861,039	113,987
Turpentine ...	867,583	108,448	676,061	92,434
Other hydrocarbon oils	1,429,114	178,871	1,695,978	247,022
Oils in composite articles	174,326	21,788	210,606	29,448
Heavy Oils:				
Derv fuel	421,069,385	52,633,673	447,802,826	62,319,034
Lubricating oil ...	167,767,568	699,032	161,155,766	671,482
Other oils	4,781,721	19,924	4,549,722	18,957
Deduct net amount paid to Isle of Man*		£316,558,069 – 425		£330,670,779 – 4,434
Deduct allowances †		£316,558,494 3,420,075		£330,675,213 3,617,961
Total imported oils	2,699,267,101	£313,138,419	2,577,064,349	£327,057,252
Light Oil:		HOME PRODUCED OILS		
From shale and indigenous crude oil—				
Motor spirit ...	10,416,053	651,036	8,161,170	626,713
Industrial spirit ...	698,580	43,661	670,775	53,040
Other spirit ...	** – 547	** – 34	1	—
Coal tar products—				
Motor benzole ...	48,975,651	3,068,976	46,483,253	3,351,693
Other benzole ...	21,422,904	1,326,948	22,949,407	1,801,099
Toluenes	9,400,695	589,182	8,836,049	694,061
Xyloles	3,368,066	210,439	3,677,796	290,377
Naphthas ...	7,728,630	483,063	7,534,927	602,819
Other spirit ...	2,827,892	176,743	3,724,220	308,840
Other sorts—				
Motor spirit ...	27,948,421	1,746,765	18,671,823	1,362,456
Other spirit ...	1,016,876	63,555	433,129	30,709
Heavy Oils:				
Derv fuel	22,944,696	1,434,044	22,228,428	1,738,290
Total home-produced oils ...	156,747,917	£9,794,378	143,370,978	£10,860,097
Petrol Substitutes ...	47,207	2,951	69,063	6,323
Power Alcohol ...	185	23	—	—
GRAND TOTAL ...	2,856,062,410	£322,934,921	7,720,504,390	£337,914,804

* Differences between amounts collected in and allocated to the Isle of Man.
† Allowances paid out of Customs receipts on accounts of rebates paid in relation to oils used in fishing boats, etc., and as raw materials for chemical synthesis.
** Excess of repayments.

U.K. Petroleum Equipment Exports

Details of the preliminary returns for 1957 exports from the United Kingdom of certain petroleum equipment are set out below, in comparison with the final figures for 1956.

	1957	1956	1957	1956
	Cwt	*Cwt*	£	£
Oil well drilling machinery	135,775	68,798	4,164,525	2,435,212
Mineral oil refining machinery	56,380	88,036	1,475,328	2,107,077
Oil fuel burning equipment	30,260	31,763	1,023,563	1,039,077
Domestic stoves for liquid fuels	87,689	104,778	2,033,692	2,276,386

U.K. TEL Exports 1957

Exports of tetra-ethyl lead from the United Kingdom in 1957 totalled 5,460,524 gallons, an increase of 620,964 gallons or 12·82 per cent over the 1956 total of 4,839,560 gallons.

The value of the exports rose by £1,502,240 to £11,929,524 and the average f.o.b. value increased by 1s per gallon to £2 3s 8d.

1957 Oil Production in Western Germany

Total production of crude petroleum in Western Germany in 1957 was 3,959,641 metric tons, an increase of 453,422 tons (12·9 per cent) over the 1956 total of 3,506,219 metric tons.

The information was supplied by *Erdöl-Informationsdienst* of Hamburg which also gives the figures for individual fields as below.

	1957	1956
	Metric tons	
Hanover	1,350,070	1,213,981
Emsland	1,240,474	1,169,813
Weser-Ems	776,261	597,861
Holstein-Hamburg	442,475	410,145
Oberrheintal	118,378	95,244
Bayern	31,983	19,175
	3,959,641	3,506,219

MIDDLE EAST PRODUCTION

	Dec. 1957	*Jan.–Dec.* 1957
	Tons	
Iraq Petroleum Co. Ltd ...	1,453,785	11,657,497
Basrah Petroleum Co. Ltd ...	1,025,623	9,140,105
Mosul Petroleum Co. Ltd ...	81,789	564,377
Qatar Petroleum Co. Ltd ...	666,182	6,504,817
Iraanse Aardolie Exploratie en Productie Mij	2,993,000	34,765,000
Kuwait Oil Co. Ltd	5,346,025	56,375,946

The refinery throughput at Abadan of the Iraanse Aardolie Raffinage Mij for December was 1,094,000 tons, the total for 1 January to 31 December being 15,180,000 tons.

Oil, Plastics, and Synthetic Rubber

THE FAWLEY DEVELOPMENT

At the end of March 1957 the Fawley Branch of the Institute of Petroleum, in conjunction with the Southern Sections of the Plastics Institute and of the Institute of the Rubber Industry, held a Symposium on the subject of the manufacture of plastics and of synthetic rubber, using as raw materials chemicals obtained from petroleum. The processes, which have recently become available are particularly related to developments in the Fawley area by Monsanto Chemicals Ltd and by the International Synthetic Rubber Co. Ltd.

The Manufacture of Ethylene and Butadiene

By **J. A. L. SPIERS***

The expansion of the petroleum chemicals industry since the war has been based on low-molecular weight olefins and ethylene in particular. Another building block which has been little used in the United Kingdom is butadiene, but the Esso Petroleum Company Limited is now building a large petroleum chemicals plant at Fawley to produce ethylene, butadiene, and other chemical intermediates.

Ethylene

All ethylene manufacturing processes have three steps: (1) formation, (2) removal of sulphur, water, and acetylenes, and (3) separation. Only methods of formation are dealt with here.

Recovery from Catalytic Cracker Gases

The well-known catalytic cracking process, for making high-grade petrol from heavy gas oils, also produces a variety of gaseous by-products, the lighter of which are normally used as refinery fuel gas, but also as a source of ethylene in favourable circumstances.

Catalytic cracker gases can produce only a limited amount of ethylene and few crackers in Europe are large enough to justify its recovery. The use of these gases allows ethylene production for a low initial investment so that it may be attractive where a fixed amount of ethylene is required and no expansion is envisaged.

Recovery of ethylene from catalytic cracker gases has two further disadvantages. First it is tied closely to gasoline operations and secondly it provides no by-products.

Coil Cracking

In coil cracking, the feedstock is passed through a tubular coil in a special furnace which has a radiant and a convection section and is so designed that the charge leaves the convection section at about 1000° F. The cracking takes place in the radiant section where the temperature is quickly raised to between 1400° and 1500° F. Immediately after leaving the furnace the cracker products are quenched either with water or oil to prevent formation of polymers and undesirable by-products.

The feedstock may either be a refinery distillate or a gas, such as ethane or propane, and can use a low value feed according to local availability of gases, naphtha, or gas oil.

Coil cracking produces a variety of by-products usable in refinery processes until a chemical outlet is found.

Steam Heat Carrier Cracking

The heat of cracking may be provided by a heat carrier, such as steam, which is superheated to about 1700° F in a special furnace while the feed is vaporized and heated to 1000° F. The charge and the feed are mixed in a transfer line where the actual cracking takes place, and the cracked products are quenched on leaving it.

Steam heat carrier cracking can use any feedstock employed for coil cracking. Since the cracking takes place in a transfer line, residence time can be kept very short to reduce polymer formation. The high steam dilution lowers the hydrocarbon partial pressure and forces the reaction in the direction of olefin formation.

The main disadvantage of this cracking is that very expensive alloys are needed in the steam superheater. Although used for catalytic dehydrogenation at somewhat lower temperatures, the process is unproven for production of ethylene.

Regenerative Refractory Cracking

Another method of pyrolysis is regenerative refractory cracking, in which a refractory previously heated by flue gases supplies the heat of cracking in a cyclic operation. During the first part of the cycle, fuel is burnt to heat the refractory to a high temperature; after some minutes fuel is turned off and the furnace is purged with steam or inert gas. The charge is then passed through the furnace and cracking takes place until further heating is required. Cracked products are quenched on leaving the furnace.

* Esso Petroleum Co. Ltd, Fawley Refinery.

Regenerative refractory cracking can handle any petroleum distillate or gas, and higher temperatures can be used than in other cracking operations. The process has been used on a pilot-plant scale to produce ethylene and acetylene.

Process to be used at Fawley

The process to be used at Fawley is a type of coil cracking known as steam cracking. Its characteristics are a coil outlet temperature of 1400°–1500° F, a short residence time at high temperature, steam dilution, and a low hydrocarbon partial pressure at the outlet.

The cracking furnace, the heart of the process, has a radiant section with a high heat density and a convection section in which the charge is vaporized and preheated to about 1000° F. The cracked products are quenched on leaving the furnace by injecting a cool oil.

Steam cracking produces a variety of by-products in addition to ethylene which, except for the butylenes and butadiene, will be used initially for fuel products.

Butadiene

There are four established methods of manufacturing butadiene. They are: (1) pyrolysis of hydrocarbons as in the coil-cracking process, (2) Houdry dehydrogenation of *n*-butane, (3) Esso dehydrogenation of *n*-butylenes, and (4) alcohol dehydration using ethanol as a feedstock. The yield is of course higher in the two catalytic dehydrogenation processes than in the other methods. Although yield is not necessarily the prime criterion, where butane or butylene is available dehydrogenation is normally preferred.

The two main dehydrogenation processes are the Houdry which can dehydrogenate butane or butylenes and the Esso which is effective only with butylenes. To force the reaction towards dehydrogenation both catalysts are operated at a low hydrocarbon partial pressure. In the Houdry process the catalyst is sensitive to steam and operates under a pressure of 2 or 3 lb abs; the Esso process works under a slight positive pressure using steam as a diluent and also as a heat carrier. A diagram of the Esso process is shown in Fig 1.

Both processes are cyclic in operation as a portion of the feed is dehydrogenated to carbon which has to be burnt off

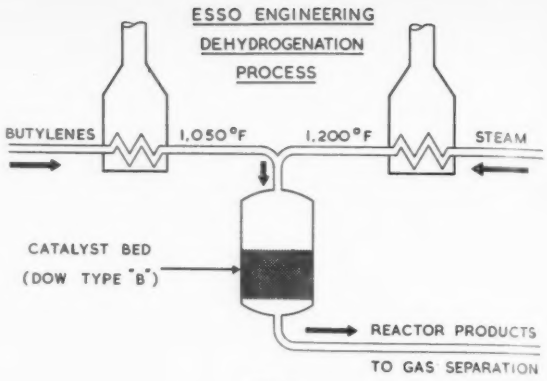


Fig 1

to reactivate the catalyst. The heat generated during the regeneration cycle provides part of the heat of reaction in the Houdry process and raises steam in the Esso process. Since air is used for regeneration a complicated sequence controller is required in both processes to ensure purging of the reactors after each reaction or regeneration.

The reaction products from dehydrogenation consist mainly of hydrogen, butadiene, and unreacted feed. This mixture must be purified to better than 98 per cent butadiene before being used for synthetic rubber manufacture. Such purity cannot be obtained by simple distillation and an extraction or extractive distillation process is required to produce the finished butadiene. The process to be used at Fawley is solvent extraction using a cuprous ammonium acetate solution as a solvent.

The dilute butadiene enters a mixer-settler train and flows countercurrent to the solvent which selectively extracts the butadiene. The optimum extraction conditions are obtained below ambient temperature and the solvent is therefore refrigerated before it enters the mixer-settlers. Reflux to the mixer-settler train is obtained by heating the final settler and thus desorbing some of the dissolved butadiene.

Plastics from Petroleum

By **K. C. BRYANT***

A recent estimate by Dr Goldstein of U.K. production of petrochemicals at the end of 1958 helps to put the subject in perspective. Output would be between 800,000 and 900,000 tons p.a., 20 per cent or 160,000 to 170,000 tons of which would be plastics.

Plastics not made from petroleum are not considered here. They include the thermosetting resins—phenol-formaldehyde (PF), ureaformaldehyde (UF), malamines, and polyesters—and the thermoplastics such as cellulose acetate, nitrate, and acetate-butyrate, nylon, and polytetra-fluoroethylene (PTFE), which leaves polyethylene, polystyrene, polyvinyl chloride, and possibly polymethyl methacrylate. PVC is normally made from carbide acetylene in Britain, but is in the main stream of petrochemical plastics in the U.S.A. where the

* Monsanto Chemicals Ltd.

oxidation of methane and the Wulff process are used to produce acetylene.

Polystyrene and styrene copolymer, polyethylene, and PVC exhibit a wide variety of properties and techniques and the paper is largely confined to them. All are made by polymerization, as distinct from condensation polymers, such as nylon and polyesters.

The monomers can be obtained directly as a refinery gas, as with ethylene, or in one or two stages, as with vinyl chloride by the route:

$$CH_2 = CH_2 \xrightarrow{Cl_2} CH_2Cl - CH_2Cl \xrightarrow{-HCl} CH_2 = CHCl$$

(or by the ingenious use of mixtures of ethylene and acetylene whereby the hydrogen chloride split off is used up) and styrene by the route:

$$\text{Ethylene} + \text{benzene} \longrightarrow \text{ethyl benzene} \xrightarrow{-H_2} \text{styrene}.$$

Polymerization Process

Bulk Polymerization

The bulk polymerization process is the oldest technique and occurs in several forms. The chief difficulty is always to control the temperature rises caused by the heat of polymerization in a viscous reaction mass. This leads to poor molecular weight control, and might also cause explosions.

The simplest form of the technique is where a catalyst is added to the monomer, polymerization then being brought about by heating. Casting of Perspex sheet is a good example.

Bulk polymerization can be carried out batchwise or continuously, sometimes with a solvent which is removed under vacuum, to reduce viscosity and facilitate agitation.

In PVC manufacture also a solvent can be added but in the vinyl chloride system the polymer is insoluble in the monomer. Hence the reaction is allowed to proceed until the slurry has an appropriate viscosity, and then the polymer is filtered off.

Another technique, basically bulk polymerization, is the suspension polymerization of polystyrene, where monomer droplets are suspended in water and polymerized by an oil-soluble catalyst, better temperature control thus being obtained.

Local economics and the properties required determine which variation of the bulk process is used. This type of polymerization has rather poor control of molecular weight, but gives good clarity although volatiles may be troublesome. Conversely, suspension polymerization is readily controlled but water removal is difficult.

Emulsion Polymerization

This is a type of polymerization where the monomer is emulsified in water; it proceeds by a basically different mechanism from suspension polymerization since the catalyst is normally water-soluble. It is used more in synthetic rubber than in plastics production because the soaps present are liable to produce slight discoloration and traces of water lead to poor clarity and both defects sound the death-knell of a general-purpose polystyrene.

Heterogeneous Catalysis

Following the discovery by Ziegler at Mulheim that a highly crystalline polyethylene can be made at low temperatures, Natta has shown in Italy that catalysts exist which not only direct polymerization so that monomers are always head-to-tail, but have a more subtle effect. If the polymer has an asymmetric carbon atom, as in any polymer derived from a monomer of the formula $CH_2 = CHR$ (*e.g.* styrene, propylene) the new catalysts can make all the R groups lie on the same side of the extended chain (isotactic) or first on one side and then on the other (syndyotactic) (Fig 1).

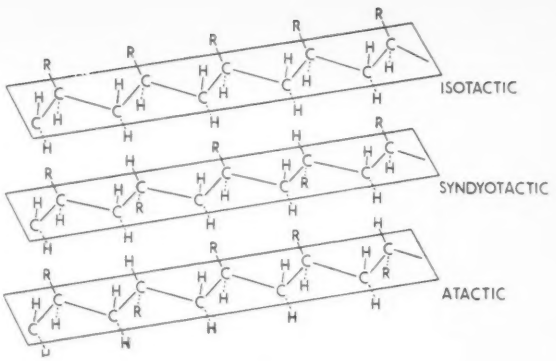


Fig 1

Conventional catalysts such as peroxides give products in which the monomer units are largely head-to-tail, but the R groups are distributed at random with respect to the side of the chain (atactic).

This symmetry in the isotactic and syndyotactic molecules produces polymers which crystallize readily and with properties different from those of the non-crystallizing variety made with conventional catalysts. Tensile properties and softening point are generally increased and solvent resistance improved stereo-specificity but shock resistance is lowered.

The degree of stereospecificity of a catalyst largely depends on its chemical nature and method of preparation. Thus, while at least three process for making highly crystalline polyethylene exist, the products are not identical.

PVC

Unmodified PVC is hard and rather brittle, but formulation with plasticizers gives any desired flexibility. The flexible materials are elastomeric, and have lower tensile strength than the rigid material.

The greatest merits of rigid PVC are chemical resistance (particularly to hydrocarbons) and lack of flammability; its greatest defect is thermal instability which causes processing difficulties. Despite these it is widely used for rigid piping, corrosion-resistant ducts, vessels, hoods and chemical equipment; rigid sheet is now being used as a vacuum forming material.

The flexibility can be varied through a wide range by using different plasticizers. Specific properties can be imparted to a flexible PVC, *e.g.* low temperature flexibility, non-toxicity, good electricals, non-flammability, and non-extractability.

PVC is used for film and belting, cables and extrusions, coated fabrics, rigids and flooring, and other applications.

Polystyrene

General-purpose (unmodified) polystyrene is a first-class material with the following advantages:—

(1) Very attractive as crystal, coloured, opaque, opalescent, etc.
(2) Moulds readily to give an excellent surface finish.
(3) Has very good tensile strength and rigidity.

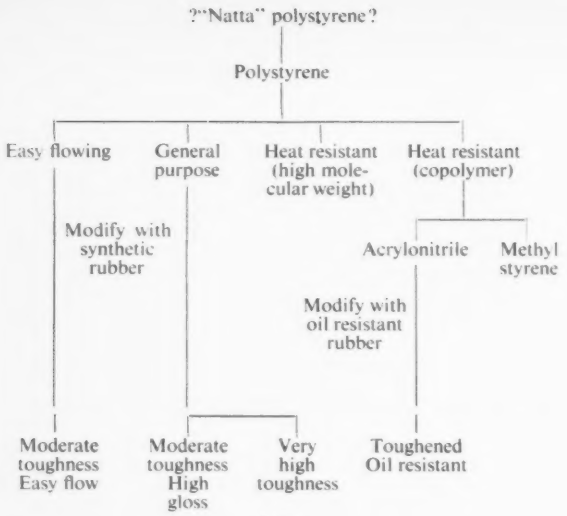


Fig 2

Its defects are:—

(a) Insufficient flexibility and impact resistance in some applications.

(b) Inadequate temperature resistance in critical uses.

(c) Insufficient oil resistance under some circumstances.

By modifying the molecule by copolymerizing or by blending with suitable synthetic rubbers, these defects can be overcome (Fig 2).

Manufacturers now tailor products for a particular object or group of objects. Thus, normal general-purpose material is too viscous for a thin-walled moulding like a well-known razor case so an easy-flowing grade was developed. Again, in certain applications some toughness is required but a good surface gloss is equally important; in others toughness is all important and gloss secondary. Furthermore, toughness may be required to be allied with oil resistance, when the acrylonitrile copolymers can be compounded with a nitrile rubber to give the required product, though at a higher cost. Products have therefore been developed for each need.

In Fig 2 all products above the dotted line are transparent, those below being translucent or opaque.

So far, no toughened polystyrene has been marketed with the clarity and water-whiteness of a general-purpose polystyrene at a comparable price, but it must be expected as a logical technical development.

It should be emphasized that every development of polymer uncovers new end-uses, which in turn require specific properties. Thus, polystyrene was initially largely an injection moulding material. The development of toughened polystyrenes has led to an expansion in its extrusion; the production of sheet in particular opened the way for its use as a vacuum-forming material

Polyethylene

High-Pressure Process

Monsanto will be operating a high-pressure process at Fawley. At a given pressure and catalyst concentration, the reaction takes place only at a useful rate above a certain temperature, and conversely with a given temperature, a certain pressure must be exceeded to give an economic rate. Accordingly high temperatures and pressures are used. The reaction itself is very complex, but shows certain of the characteristics of less sensational free-radical reactions. Thus, molecular weight decreases as the reaction temperature increases, and as the catalyst concentration is raised.

The main engineering problem is removal of the high heat of polymerization (800–1000 cal/gram compared with 164 for polystyrene) from a system of poor-heat transfer characteristics. If the heat is not conducted away, the temperature rises, the reaction accelerates, and the temperature rapidly reaches a point where the exothermic decomposition of ethylene sets in, and the system goes out of control.

This high-pressure process has enormous flexibility because an extensive range of molecular weights can be obtained (the present commercial range covers roughly a hundred-fold change in melt viscosity) and it has been demonstrated that the density range is much wider than had previously been thought.

Low-Pressure Processes

All these widely publicized processes involve a heterogeneous catalysis system operating at comparatively low temperature and pressures. In the Ziegler process the catalyst is a mixture of an aluminium alkyl and a halide such as titanium tetrachloride with a temperature of 20°–90° C, while the Phillips' process uses chromium oxide on a silica-alumina base, with temperatures in the range 100°–150° C, both with pressures under 500 p.s.i. and a suspension medium such as diesel oil.

Despite the attractive nature of these materials, and the essentially simple process, the prices may exceed that of conventional high-pressure polyethylene. This presumably arises in part from the importance of removing traces of the catalyst and solvent.

Properties

The attractions of polyethylene result from the following properties:—

(1) Flexibility over a wide temperature range without the use of plasticizers.
(2) Toughness, *i.e.* shock resistance.
(3) Excellent resistance and impermeability to water.
(4) Excellent electricals.
(5) Non-toxicity.
(6) Solvent resistance.
(7) Ease and flexibility of processing.
(8) Very wide range of application.

Polyethylene owes some of these properties to being a hydrocarbon and some to being partly crystalline.

The crystallinity is caused by the polyethylene molecules containing stretches of unbranched carbon chains; these

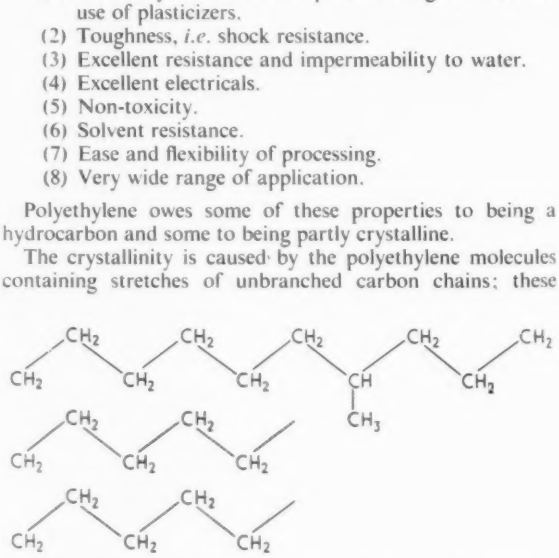


Fig 3. *Crystallization of unbranched chains in polyethylene*

regions of unbranched chain in different molecules can pack closely together to give crystalline regions, as shown in Fig 3, separated by non-crystalline regions. The side chains which have been identified in polyethylene hinder this packing-together and the fewer side chains the better the prospects of crystallization. In the crystalline regions the chains are packed closer together, and the density is higher. Consequently, the higher the crystallinity the higher the density of the polyethylene; this is the basic difference between the conventional polyethylene of density 0·92, and the low-pressure polyethylene, with density 0·95–0·96, and is illustrated in Table I.

TABLE I

	Methyl and ethyl side chains per 1000 C atoms	*Crystallinity*	*Density*
Conventional ...	21	60–65	0·92
Ziegler	3	75–80	0·95
Marlex 50 ...	1·5	90	0·96
Polymethylene ...	Nil	*ca.* 95	0·98

However, examination of the materials of the same low density from different manufacturers shows a difference in transparency in moulded articles. This arises from the grouping together of the crystalline regions, which are themselves of dimensions less than the wavelength of visible light, into spherical aggregates called spherulites, of the same or greater size than the wavelength of visible light. With the differing refractive indices of the crystalline and non-crystalline regions, the size of these spherulites determines the opacity, translucency, or transparency of the polyethylene in bulk. If they are very small, the polyethylene is almost transparent; if large, it is white and opaque. The size of the spherulites is determined by the thermal treatment the polymer has received and by the molecular fine-structure of the molecule, *e.g.* the amount of long-chain branching. When the spherulites are broken down in low-density polyethylene, as when a moulding is stretched, the stretched portion is much clearer than a moulded unstretched piece of the same thickness.

The crystallinity has a major effect on the physical properties of the solid polyethylene, increasing the stiffness, tensile properties, softening point, and solvent resistance, and decreasing the permeability—all useful improvements—but reducing impact strength or shock resistance, and affecting film clarity and gloss on mouldings.

Thus, while the development of polyethylene is in the opposite direction to that of polystyrene the products are converging. The object with polyethylene is to increase the stiffness without too much detriment to the impact strength, but with polystyrene it is to increase the impact strength without much loss of rigidity. Crystallinity is not, in itself, an advantage, unless accompanied by the required end-use characteristics, such as high shock resistance, good film clarity, and good gloss.

The molecular weight of the polyethylene governs the melt properties, and the melt viscosity is a good guide to ease of processing.

The melt viscosity is related to the molecular weight by an equation of the type:

$$\text{Log (melt viscosity)} = a + b\,M_n^{\frac{1}{2}}$$

and hence under some conditions the viscosity may be very sensitive to M_n. Thus, a 25 per cent change in M_n may alter the melt viscosity by a factor of 10.

However, crystallinity and the melt viscosity, *i.e.* M_n do not themselves define a polyethylene completely. Comparison of products of the same M_n and density from different manufacturers shows differences in some physical properties. Even more important, there are differences in applicational properties such as speed and gloss of injection mouldings, transparency of film, and smoothness of high-speed extrusion. Hence, the molecular weight distribution is also of importance.

The polyethylene that Monsanto will be making initially will be of the conventional type, not the Ziegler or Phillips' type, though it would be premature to discuss the product in detail. The polyethylene field is developing very fast and the products of say two years' time will be different from those of to-day. The high-pressure process gives products of density up to 0·940 at least; presumably products in the range 0·920–0·940 are possible if the need arises.

Polyethylene is virtually insoluble in all solvents at room temperature (which complicates molecular weight measurements which must be carried out at elevated temperatures), at all the commercially available crystallinities, and is unattacked by mineral alkalis and acids except strong nitric and fuming sulphuric acid.

At room temperature aromatic and chlorinated hydrocarbons cause some swelling with a corresponding weakening in physical properties. This increases with temperature rise and at 70°–100° C polyethylene dissolves to some extent in many solvents such as benzene, xylene, amyl acetate, chlorinated hydrocarbons, decalin, etc., the high-density materials showing less swelling and lower solubility. There are many compounds such as water, aliphatic alcohols, acetic acid, glycerol, etc., in which polyethylene is insoluble at all temperatures.

All polyethylene when stressed in contact with a polar organic liquid or a surface-active agent breaks in a brittle manner after a time. This environmental cracking is rather specific, and while the higher density materials are more resistant to some reagents (*e.g.* MEK, glacial acetic acid) they are less resistant to others, such as soft soap solutions.

The cracking resistance of high molecular weight polyethylene is much better than the low molecular weights and incorporation of butyl rubber or poly*iso*butylene brings about a marked improvement.

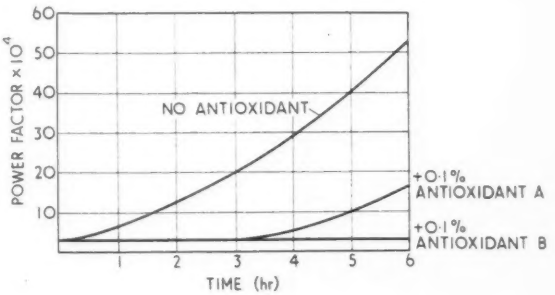


Fig 4. *Effect of milling time on power factor of polyethylene*

Ageing Properties

All polyethylene oxidizes quite rapidly in air at elevated temperatures. Thus although supporters of high-density polyethylene praise its high softening point, the problems of how high operating temperatures can be achieved are not entirely solved. This is particularly important in the H.F. electrical field, where the very low power factor of polyethylene is vital. Antioxidants of the phenol and secondary amine types are widely used to improve the thermal stability of polyethylene and the effect of milling at high temperatures with and without an antioxidant is shown in Fig 4.

Degradation in ultra-violet light is a much more difficult problem and antioxidants give virtually no protection. The only proved preventive is by the addition of about 2–3 per cent carbon black, the dispersion and particle size being very important. Therefore, in any application of polyethylene exposed to sunlight, such as cold-water piping or cable, it is normal practice to add carbon black.

Applications

An estimate of the distribution of polyethylene uses in England is given in Table II.

TABLE II

	per cent
Film	30
Moulding	30
Electricals	15
Pipe	10
Bottles and paper coating ...	10
Miscellaneous	5

Most polyethylene film is made by a process in which a thin tube is extruded, and inflated by a small air pressure, one end of the tube being closed by nip-rollers.

Polyethylene film is permeable to gases such as oxygen and CO_2 but impermeable to water (hence its use in packaging vegetables, etc.). Characteristics are given in Table III.

TABLE III

PERMEABILITY OF GASES THROUGH POLYMER

	O_2	CO_2
Cellophane	0·0003	0·001
Cellulose acetate	0·6	4·5
Polyethylene	1	50

By laminating polyethylene with a material such as cellophane, a product virtually impermeable to water and gases is obtained.

Polyethylene mouldings need no comment here, the polyethylene washing-up bowl being almost universal. The sizes of mouldings are increasing steadily and now dust-bins weighing 10 lb are being moulded in one sho .

Piping is an increasing field since polyethylene has been accepted by the Metropolitan Water Board for cold-water pipe, and is the subject of a BS specification. The manufacturers of high-density polyethylene are now dissociating themselves from the suggestion that their products are suitable for hot-water piping, although, they are of course, quite suitable for cold water if properly fabricated.

Finally, one large individual use of polyethylene has been in the transatlantic submarine cable, which has been extremely successful.

The Commercial Production of GR-S

By K. G. BURRIDGE*

Introduction

The paper attempts to complete the picture of the various major projects in the petrochemical field which are currently under construction in the Fawley area. The plant being built by the International Synthetic Rubber Company will manufacture about 50,000 tons p.a. of synthetic rubber by the copolymerization of butadiene and styrene. Of these two materials butadiene is the one used in the larger tonnage and is one of the main products of the petrochemical units currently being constructed by Esso.

To most people the name GR-S is familiar for the class of butadiene/styrene copolymers which have been produced to the extent of several hundred thousand tons per year throughout the world during the last 15 years or so. The initials stand for Government Rubber Styrene. They were chosen by the American Government to describe rubber produced under the emergency wartime programme undertaken to meet the situation arising from the loss of natural rubber supplies from the Far East after the entry of Japan into the war.

Unfortunately, as with so many other raw materials in the rubber industry, individual companies have chosen their own names such as Polysar, Chemigum, Buna S, and so on, to describe essentially similar materials. No doubt during the course of the next twelve months or so the International Synthetic Rubber Company will be devising yet another synthetic word to distinguish its products from those of other manufacturers.

* International Synthetic Rubber Co. Ltd.

The term GR-S is used in the paper to cover copolymers of butadiene and styrene in which the ratio of butadiene to styrene is about 75 to 25 per cent. GR-S rubbers thus defined may differ within limits as to their properties depending upon variations in the production process.

Some types can be produced with an especially low electrical conductivity, for use in the cable industry for example; in other cases care is taken to exclude chemicals that impart staining characteristics to the GR-S. This condition is of importance when the GR-S is to be used for instance in manufacture of rubber flooring, where colour is of importance. Other applications of increasing significance that require special types of GR-S are the latex processes. The mode of formation of GR-S latex is discussed later. It is generally known that both natural rubber and GR-S are produced initially in liquid emulsion form, this emulsion being termed a latex. Probably the most commonly known example of a rubber product fabricated from rubber initially in the form of latex is foam-rubber upholstery. Rubber gloves, etc. are also made by latex processes.

Essentially, however, the basic process for manufacture of GR-S in all its various types is similar. The International Synthetic Rubber Company's plant will be a standard type GR-S production plant and the main objective of the company is to produce a general-purpose grade of solid GR-S rubber for use by various rubber manufacturing companies in the United Kingdom, particularly in tyre production.

Historical Background

GR-S is the type of synthetic rubber which is produced in the greatest tonnage in the world to-day. The development, particularly in America and Germany, of large-scale plants was, in the first instance, due to the pressure of wartime conditions. German production started on a commercial scale in the late 1930s, and American production in 1942. The grand total of world production of GR-S has now risen to about 1,000,000 tons p.a. This compares with a natural rubber production of about 1,900,000 tons. Although initial requirements for GR-S arose because of the lack of availability in wartime of natural rubber, the reason for its present level of production is largely a matter of overall world demand for rubber. Natural rubber production has not risen in the last few years to any great extent and therefore the annual increase in world demand has largely been catered for by an increase in GR-S production. GR-S and natural rubber are here considered essentially as alternative raw materials having the same commercial applications. With some fairly important reservations, this is substantially the situation which exists to-day.

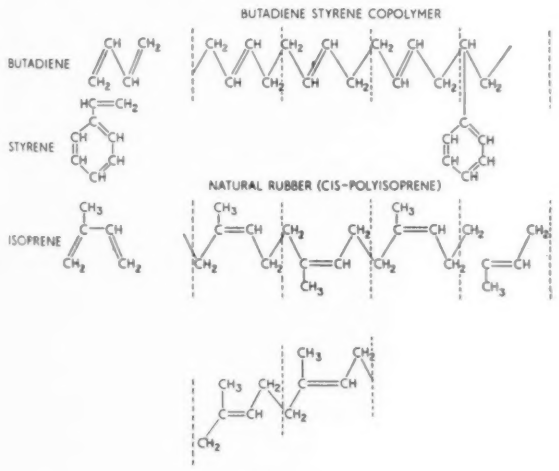


Fig 1

Fig 1 shows the structural formulae for natural rubber and for GR-S. The basic monomeric units are shown on the left, butadiene and styrene in the case of GR-S, and isoprene in the case of natural rubber.

Process Description

Turning now to the actual manufacturing process, Fig 2 shows in schematic form the various stages. The two major raw materials, butadiene and styrene, are supplied to the plant in liquid form. Although in GR-S manufacture a copolymer of these two materials is produced, they can, if allowed, both polymerize individually. This is not required, and to prevent it during their shipment to the site and storage, both butadiene and styrene are inhibited from polymerization by the addition of tertiary butyl catechol. The first operation, therefore, is to remove this material from the butadiene by washing with aqueous caustic soda which results in the tertiary butyl catechol being removed via the aqueous phase as its sodium salt. A similar procedure is not necessary with styrene as the quantity of inhibitor present is smaller, and also because the quantity of styrene required for the process is small compared with the quantity of butadiene.

The other major raw material required is a heavy mineral oil known in the synthetic rubber industry as an oil extender. The use of this is concerned with a later stage of the process and will be discussed further shortly.

The operation fundamental to the process is that of polymerization and to achieve the necessary control of the course of this reaction a relatively complex system is necessary.

Polymerization can be achieved under various physical conditions. For example, the liquid monomer, or a mixture of liquid monomers, may be polymerized in bulk, in which case the only materials present are the monomers plus the necessary catalyst system; or they may be polymerized in solution.

In the GR-S process, however, the polymerization system is an emulsion of the monomer or monomers in an immiscible liquid, water. The latter condition is that which has been used most widely so far in the commercial production of various types of synthetic rubber and in particular, in production of butadiene/styrene copolymers. It has several advantages. The advantage over solution polymerization is that the monomers, being butadiene and styrene, are hydrocarbons; therefore any solvent would necessarily be relatively expensive, and the complication and cost of a solvent-recovery system would be introduced into the process. Additionally, formation of the polymer as a dispersion or emulsion means that the synthetic rubber is first formed under similar conditions to that in which natural rubber is derived from the tree, so that the extension of the synthetic product into the field of latex processes is facilitated. Thirdly, and of greatest importance however, the use of an emulsion system permits employment of a redox catalyst, which is a multicomponent catalyst including an oxidizing and a reducing agent. In addition to the catalyst, soap, present in substantial quantities, promotes the necessary conditions

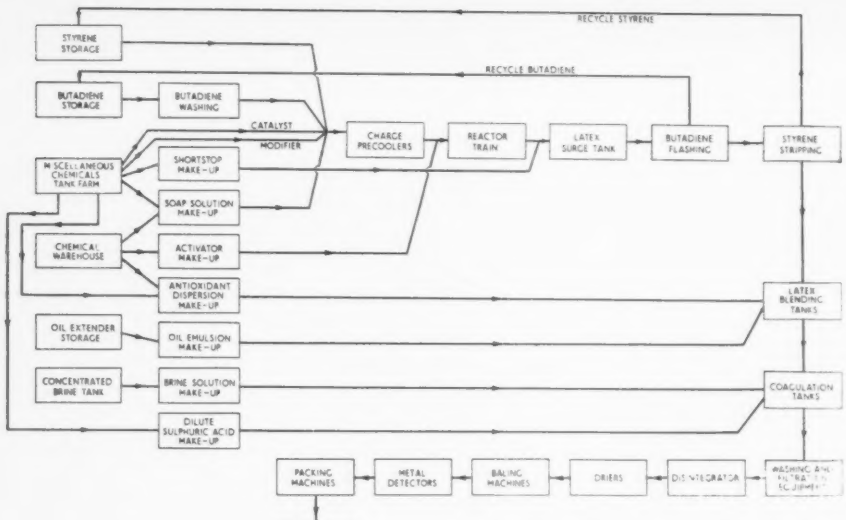


Fig 2. GR-S production—process flow plan

for the polymerization and stabilizes the hydrocarbon emulsion. Another important component in the reaction mixture is the modifier, usually a mercaptan. This material, which is soluble in the hydrocarbon phase, directs the course of the polymerization and serves to control the molecular weight.

The redox system described forms a very active catalyst for polymerization. Furthermore, since initiation of the polymerization takes place between the catalyst and the monomer molecules, solubilized in soap micelles, the emulsion system is the only one that can take full advantage of the high activity of this type of catalyst.

Before and during the last war, GR-S was customarily polymerized at about 120°F; the resulting rubber, although fairly satisfactory for the emergency conditions prevailing, did not have sufficiently good physical properties to be on a par with natural rubber. However, in about 1945–47 advances were made in redox catalyst systems that enabled the temperature of polymerization to be dropped from 120 to about 41–55°F. The new GR-S rubber is known as "cold" GR-S, as distinct from the earlier material "hot" GR-S, and it has considerably improved physical properties.

The significance of lowering the temperature of reaction may be explained in terms of the structure of the resulting

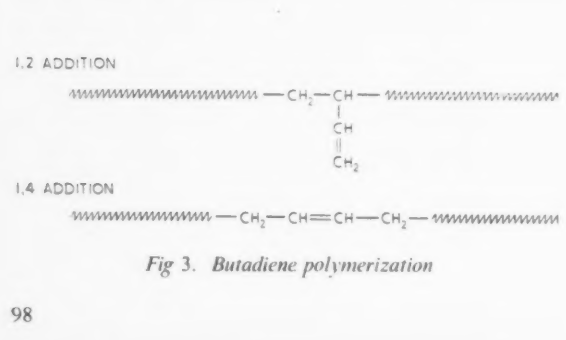


Fig 3. Butadiene polymerization

polymer chain. GR-S rubbers having desirable properties are predominantly straight chains of butadiene/styrene units. It is possible, however, for butadiene to link itself into a chain in two ways, as shown in Fig 3.

An addition of 1–4 is the preferred method of linkage of butadiene. 1–2 addition results in a pendent vinyl group which can clearly take part in further 1–2 addition and so give a branched chain. The temperature coefficient for the 1–2 addition reaction is greater than that for the 1–4 addition reaction. Thus the reduction in the temperature of the polymerization shifts the relative proportions of these two forms of addition more in favour of the 1–4 addition and hence reduces the tendency to chain branching.

The improved redox catalyst systems enabled advantage to be taken of this type of effect without extending polymerization times to impossible lengths from a commercial point of view. The old "hot" GR-S recipes produced the desired degree of reaction in 12–15 hours; nowadays "cold" GR-S polymerization is actually accomplished in a shorter time, namely, 10–13 hours.

Reverting to Fig 2, showing the process flow, the materials for the polymerization reaction are all charged together via a cooler to bring them down to the 41°–55°F temperature range, one material only being excluded—the activator. With the current type of redox catalyst system the activator comprises in general an aqueous solution of inorganic salts including the reducing agent. The oxidant is usually an organic hydroperoxide, charged via the cooler together with the rest of the charge stream. The activator, however, is not added until the point of entry to the reactors so that the operation of the catalyst system cannot commence until this point.

The reaction is allowed to proceed until approximately 60 per cent of the monomers have reacted to form polymer, and at this stage it is terminated by the addition of a shortstop. This is necessary to maintain a desirable level of properties in the resulting rubber. If the reaction is allowed to go farther towards completion an increase in the proportion of branched chains arises. Qualitatively the reason for this is that branched chains are formed by attack on existing monomer chains either by pendent vinyl groups or in the region of the double bonds remaining in the butadiene units after 1–4 linkages have occurred. As the proportion of monomer chains increases so do the opportunities for this form of attack.

A second reason for terminating the reaction before it reaches completion is that of economics. The polymerization reaction proceeds roughly in accordance with the law of mass action based on the amount of unreacted monomers remaining; hence to take the reaction to completion would result in an uneconomically long residence in the reactor system. Against this, if the reaction is stopped too early, excessive

quantities of unreacted monomer have to be recovered. This would require an increase in the size of the monomer recovery system with a consequent increase in operating cost.

The process so far discussed has produced a latex of synthetic rubber wherein the solid content, namely, the rubber, comprises about 20 per cent by weight. In addition there is about 10 per cent by weight of unreacted monomers. The next step, therefore, is to remove the latter. The butadiene has a low boiling point of approximately 24°F; hence its removal from the latex is fairly straightforward from a physico-chemical point of view. The temperature of the latex is raised to about 120°F and the pressure is reduced in stages to about 200 mm abs. In this way all the butadiene is effectively removed. The latex after this stage may be termed partially stripped because, while the butadiene has been removed, the styrene, which is a relatively high boiling hydrocarbon, is still present. The next stage is to remove the styrene, which is accomplished by vacuum steam distillation. The latex, free from both butadiene and styrene, then passes to the finishing stage.

To produce the rubber in solid form it is necessary to coagulate the latex and remove the aqueous medium. Before doing so, one or two materials may be added to compound the latex. The first is an antioxidant which retards the reaction of oxygen with rubber. It is incorporated at this stage so that the latex after coagulation to rubber will not deteriorate at the high temperatures of its passage through the drying ovens. The antioxidant is customarily added by first making it into a dispersion or emulsion and then stirring it into the latex.

The second possible additive is mineral oil or oil extender. The reason for adding it can be seen by considering again the course of the polymerization reaction. One factor controlled by the modifier is the overall average molecular weight of the polymer chains. An increase in the molecular weight is generally advantageous in improving the properties of the finished rubber. This increase can readily be achieved by adjustment in the modifier content. Unfortunately full advantage of this improvement in physical properties cannot be taken because of the fairly extensive mechanical processing operations to which the rubber is subjected in the rubber factories. All rubbers have to be compounded with a variety of ingredients, *e.g.* sulphur to permit vulcanization, and carbon black to increase the modulus and abrasion resistance. These are added in Banbury mixers or on mills, and their incorporation is accompanied by intensive kneading, which is exceedingly vigorous and, particularly because of the oxygen in the air, can result in substantial reduction in the molecular weight of the rubber. The reduction will be relatively greater for rubbers of high molecular weight and hence in practice there is a limit to which the molecular weight can be increased with advantage.

In the last five or six years the use of oil extenders has developed; these, when added to very high molecular weight rubbers, act rather like plasticizers for the rubber during fabrication operations in the rubber factory. The oils thus added are heavy fractions similar to lubricating oils in many respects and their advantage is in terms of economics rather than in terms of superiority of the properties of the oil-extended rubber. Thus, two routes are possible: polymerization may be carried out to a moderate molecular weight and the resulting rubber sent directly to the rubber manufacturer, or polymerization may be carried out to a very high molecular weight and the resulting rubber plasticized by the addition of oil extenders. In this way a high molecular-weight rubber plus an oil extender provides a material not very different from the straight synthetic rubber of a lower molecular weight.

The overall cost of the product, however, is reduced because the extender oil is cheaper than either butadiene or styrene. There is a considerable consumption of both these types by rubber manufacturers. The choice is determined by whether the slight advantage of the straight GR-S rubber over the oil-extended GR-S justifies the price differential.

The oil extender is formed into an emulsion and added to the latex by a simple stirring operation. The latex is then coagulated by addition of sodium chloride solution and dilute sulphuric acid, yielding a slurry of rubber crumb in an aqueous medium. The remainder of the process comprises simply removal of the aqueous medium by filtration, washing of the rubber, followed by further filtration, and finally by drying and baling. The rubber is compressed into 80 lb bales and passed to storage preparatory to dispatch.

Reverting to the monomer recovery stages, the butadiene removed by the flashing operation is condensed and as far as possible is blended off with fresh butadiene and re-used. Generally, all the recycle butadiene cannot be disposed of in this way, and some is returned to the suppliers for re-purification. With styrene the whole of the recycle material can be disposed of by blending with incoming fresh material.

Turning now to the industrial plant used in these operations, let us consider the plant being erected for the International Synthetic Rubber Company at Hythe. A considerable part of the plant is concerned with operations rather similar to refinery operations, and much of the equipment at this stage comprises tanks, vessels, pumps, pipework, and so on, as seen on a refinery. The only significant difference is the extent to which these are housed; a great part of the plant is contained within buildings. Only the butadiene and styrene tank farms, the miscellaneous chemicals tank farm, and the recovery area equipment are outside. The solution make-up operations are carried out in a building, as are polymerization and the finishing operations. The polymerization plant is designed for continuous operation and comprises two trains of reactors in parallel; its overall capacity is 50,000 tons p.a. of copolymer and each reactor train therefore produces 25,000 tons p.a. Each reactor comprises a vertical vessel of about 4200 I.G. capacity with internal cooling coils and a central stirrer, and the polymerization charge mixture passes in series from one vessel to another from beginning to end of the train. The butadiene recovery operation is accomplished in horizontal cylindrical vessels maintained at a suitably low pressure and through which the latex flows continuously. The vacuum stream distillation operation for removal of unreacted styrene takes place in perforated plate columns, the latex passing down and the steam passing up the column.

Latex is coagulated in vigorously stirred tanks, the crumb being removed from the aqueous medium during its passage across a vibrating screen.

After the washing operation the wash water is removed from the crumb via a rotary vacuum filter. This causes aggregation of the crumb, which then has to be broken down again in a disintegrator before passage to the drying ovens. These are conveyor driers having three tiers, the rubber entering at the top conveyor and being discharged from the bottom conveyor. The dried rubber crumb is then baled in hydraulic presses and packed either in a plastic film or a suitably coated paper bag.

Finally the properties and applications of GR-S in rubber manufacture are briefly dealt with as follows.

GR-S vulcanizates do not develop physical properties in any way comparable to natural rubber vulcanizates unless compounded with carbon black or some other reinforcing filler such as a silicate. In practice, natural rubber as well as GR-S, nearly always has a reinforcing filler added as part of the pre-vulcanization compounding procedure, but this is not essential with natural rubber.

It is rather difficult to offer a quantitative theoretical explanation of this difference between the two materials. However, from Fig 1 one or two qualitative reasons can be seen by a consideration of the structural formulae. First, the chemical name for natural rubber is *cis*-poly*iso*prene. Transpoly*iso*prene, as shown by the structural formula at the bottom of the figure, is also produced naturally, gutta percha and balata being examples.

With these naturally occurring materials the polymerization mechanism is stereo-specific, so the structures arising are quite regularly *cis* in natural rubber, and *trans* in the other two materials. In the case of emulsion polymerization of butadiene and styrene to GR-S the polymerization system is not stereo-specific, and a random mixture of *cis-trans*-orientations occurs in the butadiene section of the chains.

Another difference between the two structures is in terms of the pendent groups. The pendent groups in the natural rubber chain are methyl groups, which are reasonably small and occur at quite regular intervals. The pendent groups in the GR-S chains are phenyl groups, which are appreciably larger and occur at random intervals.

In a natural rubber vulcanizate containing no reinforcing filler the material under extension can arrange itself in terms of molecular configuration in a reasonably regular fashion, so that intermolecular forces can play a significant part in promoting tensile and other properties. The greater irregularity in the GR-S chain and the greater effect of the steric hindrance of the phenyl groups preclude advantageous effects such as this being exhibited by GR-S to any substantial degree.

Briefly comparing compounded GR-S with compounded natural rubber, natural rubber has the advantage in resilience but GR-S has some advantage in abrasion resistance. This is reflected in the usage pattern of the two materials *e.g.* comparing passenger tyres with commercial vehicle tyres the latter are considerably larger and have a considerably greater bulk of rubber per tyre, and hence a high resilience rubber such as natural rubber is preferred to minimize heat build-up effects.

This reduces the hysteresis loss of the tyre when running and its tendency to overheat. On the other hand the improved abrasion resistance of the GR-S can be applied to passenger-car tyres with advantage because wearing by abrasion occurs particularly on cornering, and in general, passenger cars corner at greater speeds than commercial vehicles.

As the commercial outlet for GR-S at present is largely in tyres, the fact that it is used more in passenger car tyres has an important bearing on the relative proportions of GR-S to natural rubber consumption in different countries. For example, in the United States the consumption of synthetic rubber is approximately 60 per cent of the total American consumption; in the United Kingdom the figure is only 20 per cent of the total. This difference is partly due to the fact that the proportion of passenger car tyres in the U.K. to commercial vehicles is very much lower than the ratio in the U.S.A.

It has, of course, been in the interest of the United Kingdom to maintain the consumption of natural rubber in view of the large U.K. investment in Malaya, and also in view of the fact that the rubber from the East Indies and Malaya is not a dollar purchase.

Discussion

Asked whether the phases in the butadiene-extraction process were liquid/liquid or gas/liquid Mr Spiers replied that two liquid phases were to be used and mixer-settlers had been chosen in the extraction train for that reason. The process could also operate with butadiene in the vapour phase and was cheaper than gas/liquid extraction.

In a further answer he stated that steam was used in the Esso coil-cracking process to reduce the hydrocarbon partial pressure to force the cracking reaction in the direction of olefin production. It lessened coke formation in the furnace coils, acted as a heat carrier, and permitted rapid carrying of the hydrocarbon component through the coils.

The propylene produced by steam cracking would be used initially for gasoline manufacture by polymerization. The products of steam cracking were hydrogen, and by the dehydrogenation reaction, methane, ethylene, propylene, butene, butadiene, heavier dienes such as *cyclo*-pentadiene, benzene, toluene, some xylenes, etc.

Steam, however, was not the only possible gas for partial pressure reduction. Nitrogen was feasible but more costly, and a coil-cracking process could be operated without a diluent at all.

In reply to questions Mr Spiers said that production at Fawley was planned to start on 1 July 1958. The styrene would be supplied from Forth Chemicals.

Mr Burridge said that the oil used as an extender for high molecular weight GR-S was a heavy petroleum, similar to lubricating oil. It was of high viscosity and of no great value for other purposes. An important quality was its aromatic or naphthenic content, there being a slight preference for an aromatic oil.

Asked if there would be a switch towards isoprene chemicals, Mr Spiers thought that, if polyisoprene was meant, it could not compete economically with GR-S or natural rubber at present prices.

Mr Burridge said his Company preferred to make GR-S in a train of reactors rather than in a single unit because that aided production and gave the required stirring characteristics and heat-transfer rates. A single reactor had disadvantages in charging and drawing off.

Dr Barron gave some statistics on production of natural rubber —about 1·9 million tons p.a.—and synthetic rubber about 1 million tons p.a., with an estimated world demand in a few years of 4 million tons p.a.

It should be remembered that it took seven years from planting a rubber tree to the production of natural rubber, while synthetic took only two years from the start of a project. He asked for more information on Professor Natta's polystyrene, and Mr Bryant said it was not yet possible to evaluate fully Natta's material. It had properties which might make it important, but its melting point of 220° C meant fabrication temperatures of 250°–300° C. That might not be a serious disadvantage if its solvent resistance was superior to that of normal polystyrene, as with polyethylene the more crystalline the material, the less flexible and the less shock-resistant it became.

Replying to a question on u.v. absorbers and their use in polyethylene Mr Bryant said those "sun-screens" were not satisfactory and were inferior to carbon black.

A speaker suggested that the capital investment required for natural and synthetic rubber production was about the same. Therefore comparisons rested on costs of raw materials and labour for natural rubber against cost of raw material for synthetic rubber.

Mr Burridge thought that production in tons per year per man in a synthetic plant was about 20 times as great as that on a plantation.

On a question regarding terminology Mr Bryant said that with regard to "percentage of crystallinity" the material chemically was homogeneous but not physically. An analogy was unvulcanized rubber containing many small vulcanized patches.

As regards "melt viscosity" for polythene the conventional figure was 190° C. In a specialized test it was quoted as "fluidity" or "melt index". A melt index of 2 meant that 2 g would be extruded in 10 min under standardized conditions.

Asked why a high molecular weight polythene or low molecular weight polythene plasticized with PIB was good for resistance to environmental cracking, Mr Bryant said that a detergent molecule would orient itself at the water-polyethylene interface and the hydrocarbon part would tend to penetrate the amorphous regions between spherulites and act as a plasticizer, separating the polymer chains and weakening their adhesion to one another.

The lower the molecular weight the larger was the number of chain ends and the lower the strength. By incorporating a high molecular-weight PIB or butyl rubber the number of links from one crystalline region to the next was increased.

High-density polyethylenes were preferable for organic liquids than swelled polyethylenes but were more susceptible to soaps and detergents.

Environmental cracking resistance increased with weight and comparative data was difficult to obtain. Solution viscosity was a guide but he preferred to use number average and weight average molecular weights. He was not sure whether the higher density materials had sufficient molecular weight for good cracking resistance, but with low-density polyethylenes of good low-temperature brittleness, cracking resistance, etc., seemed to set in rather sharply at a melting index of about 2.

The number average was measured osmotically but the weight average was by light-scattering techniques, both at high temperatures.

World Oil Production in 1957

Estimating total crude oil production during 1957 as nearly 881 million metric tons, the *Petroleum Press Service* sums up the position as follows: "The immediate and secondary impact of the Suez crisis, the slowing down of economic activity in the U.S.A. and sluggishness of oil demand in various markets in recent months, were the main factors determining the course of the free world's oil production last year. This rose by a net amount of 29 million tons, mainly the result of higher outputs in Venezuela, Persia, Kuwait, and Indonesia but a temporarily lower output in Northern Iraq. Production in the U.S.S.R. rose by over 14 million tons. The prospect is that the expansion of the free world's output this year will again be below the average of recent years."

Details given of production by countries and areas are reproduced in the accompanying table.

WORLD: ESTIMATED CRUDE OIL PRODUCTION

(Thousand metric tons)

	1955	1956	1957	% Inc. over 1956	% of world
North America					
U.S.A.: California ...	47,821	47,376	46,600		
U.S.A.: East of California ...	287,110	305,473	305,400		
	334,931	352,849	352,000	*dec.* 0·2	39·9
Canada	17,426	23,126	24,500	6·0	2·8
	352,357	375,975	376,500	0·1	42·7
Latin America:					
Caribbean Area					
Venezuela	112,379	128,923	146,300		
Colombia	5,768	6,284	6,450		
Trinidad	3,564	4,129	4,970		
	121,711	139,336	157,720	13·2	17·9
Other Countries					
Mexico	12,599	12,796	12,600		
Argentina	4,469	4,408	4,950		
Peru	2,304	2,459	2,500		
Brazil...	260	530	1,300		
Chile	332	462	550		
Ecuador	465	450	450		
Bolivia	351	417	450		
Cuba	49	70	70		
	20,829	21,592	22,870	5·9	2·6
Middle East					
Kuwait	54,756	54,982	57,300		
Saudi Arabia ...	47,535	48,622	49,000		
Persia	16,205	26,530	35,500		
Iraq	33,648	31,313	21,000		
Qatar	5,438	5,876	6,500		
Kuwait Neutral Zone	1,362	1,670	3,480		
Egypt...	1,823	1,723	2,000		
Bahrain	1,499	1,507	1,670		
Turkey	202	296	300		
Israel	—	30	70		
	162,468	172,549	176,820	2·5	20·1
Far East					
Indonesia	11,790	12,652	15,000		
Br. Borneo	5,308	5,558	5,750		
India	330	380	430		
Burma	199	236	380		
Western New Guinea	474	375	350		
Japan...	319	314	315		
Pakistan	276	290	290		
	18,696	19,805	22,515	13·6	2·5
W. Europe					
Germany	3,147	3,506	3,600		
Austria	3,666	3,428	3,180		
Netherlands	1,022	1,094	1,500		
France	875	1,261	1,400		
Italy	205	567	1,400		
Yugoslavia	257	293	400		
U.K.	54	67	80		
	9,226	10,216	11,560	13·1	1·4
Africa (excl. Egypt)					
Angola	—	9	150		
Gabon	—	—	144		
Morocco	102	97	75		
Algeria	57	34	15		
	159	140	384	174·3	—
FREE WORLD					
Western Hemisphere	494,897	536,903	557,090	3·8	63·2
Eastern Hemisphere	190,549	202,710	211,279	4·2	24·0
	685,446	739,613	768,369	3·9	87·2
Eastern Europe and China					
U.S.S.R.	70,793	83,796	98,000		
Rumania	10,575	10,920	11,500		
Hungary	1,600	1,200	660		
Albania	220	280	300		
Bulgaria	150	230	280		
Poland	180	184	190		
Czechoslovakia ...	140	140	140		
China(*)	966	1,176	1,500		
	84,624	97,926	112,570	15·0	12·8
WORLD TOTAL ...	770,070	837,539	880,939	5·2	100·0

(*) Including shale oil.

IMPORTATION OF LIQUID NATURAL GAS

Sir Harold Smith, chairman of the Gas Council, made the following announcement in London recently.

A contract has been signed between the Gas Council (Great Britain) and the Constock Liquid Methane Corporation of America for the experimental importation into Great Britain of liquefied natural gas by sea.

A cargo ship, jointly owned by the Gas Council and the Constock Liquid Methane Corporation, is being converted and after conversion will be able to carry about 2000 tons of liquid natural gas. It is hoped that the first shipload will arrive in the Thames within about 12 months.

If this experiment proves successful it is hoped that the way will be open, subject to Government sanction, to the importation of liquefied natural gas in bulk. The Gas Council is examining every possible way of producing gas by cheaper methods. This is one method under review.

A statement by the Gas Council says:—

The liquefaction of natural gas and its transportation in the liquid form presents no easy problem, for methane, the principal constituent of natural gas, requires a temperature of —260° F for liquefaction at atmospheric pressure and the material must be maintained under these conditions during transportation. When liquefied, its volume is reduced to 1/600th of the space it occupies in gaseous form.

Processes for the liquefaction of gas have now been developed to an advanced state and the major portion of the technical difficulties has been overcome. What is new is the attempt to convey, by ocean-going vessel, fluids in insulated tanks at such extremely low temperatures. The success of the experiemtns now being undertaken will depend largely upon whether, technically and economically, this sea-borne transport has the results which are hoped.

The Trial Shipment of Natural Gas

It is proposed to take the first trial loads of natural gas from the Gulf Coast oilfields. For the trial shipment it is proposed to use an already existing liquefaction plant which has been constructed on a barge, and which can be transported to any site in the area at which the natural gas may be loaded. This plant has a capacity of about 8 million cu. ft of natural gas a day. The liquefied gas will be stored in tanks on shore before being loaded into the vessel for shipment.

The vessel which is being converted for the trial load is a double-bottomed cargo ship about 340 ft in length which will carry about 2000 tons of liquid methane.

The liquid methane will be contained in five tanks insulated with balsa wood and their overall design and location will be such as to accommodate the effect of the ship's movement at sea. As the liquid methane cargo is exceptionally light the ship will be specially ballasted.

The design and engineering work for the conversion is being handled by J. J. Henry & Co., New York, marine architects, and the work is being carried out by the Alabama Dry Dock and Shipbuilding Co. Inc at Mobile, Alabama.

Use in Britain

The marine terminal for the acceptance of the trial shipment in Britain will be at Canvey Island on land belonging to the North Thames Gas Board and where there are suitable deep-water facilities. The two 1000-ton storage tanks necessary to deal with the trial shipment are now under construction. The contractors for this work on behalf of the Board are the Whessoe Company Ltd, and the Aluminium Plant and Vessel Company Ltd.

The liquid natural gas will be pumped from the cargo tanks on the vessel to the shore tanks by specially designed ships' pumps through a pipeline with a 6-inch covering of insulation. Although these shore storage tanks are heavily insulated there will be a continuous boil-off of gaseous methane from the liquid and this material will be contained in a small gasholder of the dry-sealed Wiggins type, whence it will be pumped into the mains system. Liquid methane will be vaporized by heat exchange with water or steam and there is no intention at this stage of making use of the cold content or the refrigerating capacity of the methane. The liquid methane will be converted to gas under pressure and this pressure will be used to convey the gaseous methane into the Board's transmission lines. A new transmission line is being laid from Canvey Island to connect with a high-pressure main already in existence between Shell Haven and Romford works and the gaseous methane will mix with refinery gases from the Shell Haven refinery.

The town's gas supplied in the North Thames Gas Board is distributed at 500 B.t.u/cu. ft while the methane has a calorific value of 1000 B.t.u/cu. ft, and transformation of the methane into gas of 500 B.t.u/cu. ft will be carried out at Romford by the Onia-Gegi catalytic process.

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BRITISH OIL PRICE CHANGES

With effect from 11 February the wholesale prices of all grades of motor spirit in the U.K. were reduced by ¾d. per gallon. Recommended retail prices in the general zone thus became: super grades, 5s. 0½d.; premier grades, 4s. 9d.; and ordinary grades, 4s. 3d. per gallon. In the inner zone, recommended retail prices are 1d. less per gallon and in the outer zone ½d. less. At the same time the wholesale price of derv fuel was reduced by ½d. per gallon.

On 12 February the wholesale prices of aviation turbine fuel and of the 108 and 115 grades of aviation gasoline were reduced by 1d. per gallon. The 100 grade of aviation gasoline was reduced by ½d. per gallon. Burning oil, gas oil, and light fuel oil were reduced in price by ½d. per gallon on the same date, when also the prices of vaporizing oil and heavy fuel oil came down by ¼d. per gallon. Current wholesale prices are thus:

	General Zone	*Inner Zone*	*Outer Zone*
	Price per gallon in 200-gal. lots		
MOTOR SPIRIT	s. d.	s. d.	s. d.
Standard	3 10	3 9	3 9½
Premier	4 3½	4 2½	4 2¾
Super	4 6¼	4 5¼	4 5¾
AVIATION SPIRIT:			
73 octane	4 6½	4 5½	4 5¾
91/96 octane	4 6½	4 5½	4 5¾
100/130 octane	4 7	4 6	4 6½
108/135 octane	4 7¾	4 6¾	4 7¼
115/145 octane	4 7¾	4 6¾	4 7¼
AVIATION TURBINE FUEL:			
2482	1 4¾	1 3¾	1 4¼
2486	3 10½	3 9½	3 10
KEROSINE:			
Burning oil	1 5½	1 4½	1 5
Premier burning oil	1 7	1 6	1 6½
Vaporizing oil	1 5½	1 4½	1 5
	Price per gallon in 500-gal. lots		
DERV FUEL...	3 10½	3 9½	3 10
DISTILLATE AND FUEL OILS:			
Light distillate	1 4½	1 3½	1 4
Diesel and gas oil	1 4¾	1 3¾	1 3⅞
Fuel oil, 200 sec.	1 1⅞	1 0⅞	1 1⅛
Fuel oil, 950 sec.	1 0¾	11¾	1 0¼
Fuel oil, 3500 sec.	1 0¼	11¼	11⅜

New Books

1957 Book of the Year

Looking back on the past, even if only for a short while, has an irresistible attraction for most people, and looking back on the past year has perhaps the greatest fascination of all.

This inclination is gratified by Shell-Mex and BP's 1957 *Book of the Year*, which recalls the highlights of the twelve months that began under such gloomy auspices for the oil industry.

A salute to the nation opens the book. The buoyant optimistic style deals with Britain's achievements in building, power production, railway modernization, shipbuilding, and domestic purchases. Even the improvement in the nation's health is not forgotten, and the decrease in deaths from tuberculosis is quoted as phenomenal.

The activities of the Shell-Mex and BP organization are naturally rather more fully covered than the general state of Britain. Many of the company's developments are recorded, a number of which such as the new depots at Teesport and Sheffield, the launching of the last of nine estuarial tankers, and the growth in popularity of oil-fired heating appliances, have been referred to in the *IP Review* during the course of the year.

Industries that consume vast quantities of petroleum products are given special attention; of these steel heads the list, for that industry in 1956 accounted for a quarter of Britain's consumption of fuel oil. The human-interest stories woven into the fabric of technical facts and forecasts of output enliven this very readable article.

Although no new British jet air-liner flashed across the sky in 1957, the year was notable in the aviation industry for record export orders, the first vertical take-off aircraft, and for an English Electric P1 fighter exceeding the world's official air speed record.

A section on agriculture gives very encouraging figures on output from the land, but 1957 might best be remembered by farmers for the introduction of a Capital Grants Scheme for farm improvements under which the Government would provide up to 33⅓ per cent towards the cost of long-term improvements on the farm. How valuable and important this scheme is can be gauged from the degree of mechanization now existing in the agriculture of Great Britain. It is estimated that there are half a million tractors and nearly 33,000 combine harvesters engaged in tilling the fields today!

A gallery of photographs of many subjects completes this book. Since many of the topics have been dealt with in the *Review* it is sufficient to mention but a few, such as delivery of fuel to the atomic energy plant at Dounreay, the Company's road safety game "Children and Traffic", and members of the Company's staff who received awards in the Queen's Birthday and New Year Honours Lists.

Conference Technology

Compiled by a group of professors and professional interpreters, a pocket-sized compendium on Conference Technology in six languages has been published by Elsevier Publishing Co. of Amsterdam.

Under the general editorship of Jean Herbert, former chief interpreter of the United Nations, the booklet caters for the needs of the delegate—if not from the cradle to the grave, at least from acknowledging receipt of a letter of convocation to the final adjournment of the meeting.

The book does not pretend to remove all the difficulties of being intelligible in a foreign language but it does supply all those technical terms that just will not come to mind when they are needed at the Conference—and it lists them in German, French, Italian, Spanish, and Russian, in addition to English.

Conference Technology is handled in Britain by Cleaver-Hume Press Ltd, 31 Wright's Lane, London, W.8, from whom copies can be obtained at the price of 12s 6d.

Opportunities for Graduates in Industry

The university graduate, whether in science or arts, is often interested in a career in industry, but may be deterred by the lack of reliable information on the vacancies and requirements of individual firms.

This deficiency of data is remedied by *The Directory of Opportunities for Graduates*, the 1958 edition of which has recently been published. More than 200 business organizations appear in the reference section, and each entry opens with a brief survey of the company, its approximate number of employees, its products, and the locations of its factories. The type of graduate sought is stated and the training provided is outlined. Approximate starting salaries are quoted in most cases, and the graduate accordingly finds that the selection of a firm suitable for his qualifications is made comparatively simple.

The editorial section includes an interview between a recent arts graduate and C. E. Escritt, secretary of Oxford University Appointments Committee and R. W. Pennock, Central Staff Department, ICI Ltd. The subject discussed is selection methods, and the account is given in the form of a verbatim conversation in which qualities required of a candidate are defined and considered. First-hand experiences of graduates in industry are covered by four articles on subjects as diverse as heavy engineering and advertising.

Copies of the directory are distributed free to all final year university students in the United Kingdom, and can also be obtained from the Cornmarket Press Ltd, 1 Lower St James' Street, London, W.1, at the price of 9s 4d post free.

Published by the same firm is a *Directory of Opportunities for School Leavers*, which has much the same format as the Directory for graduates, but it details the standard required in the G.C.E. from applicants, the age group that will be considered, and the openings for boys or girls. Copies are distributed free to the heads of all public, grammar, and secondary schools in Britain. The price of the book for other interested purchasers is 7s 6d.

Higher Technological Education

The ninth annual report of the Regional Advisory Council for Higher Technological Education, covering London and the Home Counties, for the year ending 31 August 1957 has been issued.

It includes brief reports from regional advisory committees, lists of members of Council and committees, and the balance sheet for the financial year.

Copies are obtainable free from the Council at Tavistock House South, Tavistock Square, London, W.C.1.

Exhibitions and Conferences

Mechanical Handling Exhibition

The Mechanical Handling Exhibition and Materials Handling Convention, to be held at Earls Court, London, from 7–17 May, will be the largest display of labour-aiding equipment and methods ever assembled in one hall.

The exhibition will be international in character and more than 250 firms will take part. The Materials Handling Convention will run concurrently with the Exhibition and papers will be presented by leading authorities in many different industries.

Further details of the biennial show can be obtained from the Exhibition Manager, *Mechanical Handling*, Dorset House, Stamford Street, London, S.E.1.

Chemical and Petroleum Engineering Exhibition

First of its kind to be presented in Britain, a Chemical and Petroleum Engineering Exhibition, sponsored by the British Chemical Manufacturers Association and the Council of British Manufacturers of Petroleum Equipment, is to be held at Olympia, London, from 18–28 June.

More than 200 exhibitors will be represented and their stands will occupy 125,000 square ft in two halls.

From 24–26 June the Institution of Chemical Engineers, in conjunction with the Institute of Petroleum, will stage a symposium on "The Organization of Chemical Engineering Projects" and papers will be presented at four sessions spread over three days. The symposium will also form part of the 1958 programme of the European Federation of Chemical Engineering.

Films will illustrate the valuable contribution that Britain's chemical and petroleum engineering firms are making to the growth of industry.

Details of the Exhibition can be obtained from F. W. Bridges and Sons Ltd, Grand Buildings, Trafalgar Square, London, S.W.1, and of the symposium from the Secretary of the Institution of Chemical Engineers, 16 Belgrave Square, S.W.1, or the Institute of Petroleum, 61 New Cavendish Street, London, W.1.

BIM-Polytechnic Executive Programme

The BIM-Polytechnic Executive Programme which covers management control, production management, organization and administration, marketing, industrial relations, and communication, is unique in such training because it is co-sponsored by a major professional body, the British Institute of Management, and a large academic organization, the Polytechnic.

The first course began in February but further courses will start on 14 April and 10 November this year.

Further details of the courses, which last four weeks and cost 100 guineas for tuition, can be obtained from The Polytechnic, Department of Management Studies, St. Katherine's House, 194 Albany Street, London, N.W.1.

INTERNATIONAL PLASTICS TRADE FAIR 1959

The 1959 plastics trade fair is to be held in Düsseldorf from 17 to 25 October.

International participation will not be restricted to the machinery and accessories industries but will include the plastics-producing and plastics-processing industries.

The technical organization of the fair is in the hands of Nordwestdeutsche Ausstellungs-GesellschaftmbH, (NOWEA), Düsseldorf, Ehrenhof 4.

THE LAUNCHING OF *ESSO BRISTOL*

At five minutes past three on Saturday afternoon, 1 February, at the Hamburg shipyards of Howaldswerke A-G, Mrs Frances Chilvers, the wife of the honorary secretary of the Institute and a director of Esso Petroleum Company Ltd, calmly and clearly pronounced the name of the 36,000-ton tanker that towered above her head, wished her and her ship's company good fortune, and *Esso Bristol* slid gracefully into the waters of the Elbe. So ended *Esso Bristol*'s first short journey.

The launching was presided over by T. Schecker, the managing director of Howaldswerke A-G, the builders of the ship. The guests included the Lord Mayor and Lady Mayoress of Bristol, H. C. Tett, managing director of Esso Petroleum Company Ltd, and his wife, C. Chilvers and his daughter, Miss Angela Chilvers, and many others.

It must be admitted, however, that this was certainly no ordinary launch. At 5 o'clock on the previous evening, Mr Tett, Mr Chilvers, and five of their fellow guests were safely gathered in Hamburg, whilst the rest of the party, including Mrs Chilvers, the sponsor of the ship and the star performer, were helplessly fogbound at London Airport, with every airport in Northern Europe out of action.

It was then perhaps that one saw the flexibility and dynamism of the oil industry at its best. Somehow, by masterly staff work, the Esso Company managed to bring Mrs Chilvers and all the guests, by boat and train, into contact with *Esso Bristol* in the very nick of time. With the thousands of tons of ship held stationary only by two slender triggers, and the deadline of 3.30 p.m. imposed by the tide ominously running out, the sponsor arrived completely unruffled at 2.55 p.m.! At 3.05 it was all triumphantly over . . . except, of course, for the celebration in the evening; when a banquet was given by Howaldswerke in the magnificence of the "Four Seasons" in Hamburg, and the few speeches, including that especially of the Lord Mayor of Bristol, testified to the excellence of the occasion.

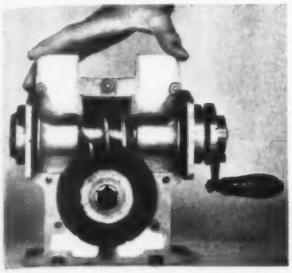
Unfortunately, the fog persisted over the whole week-end, and further emergency arrangements had to be improvised to get some of the party back to London by Monday morning (including the general secretary of the Institute and his wife). The feats accomplished in conjuring seats and cabins out of the travel chaos that had engulfed the whole of Europe by then will be an added memory to an already memorable occasion.

Mrs Chilvers with her daughter and Mr Chilvers at the launching of Esso Bristol

Trade Literature, etc.

New British High-Performance Rotary Pump

Substantial savings in weight and driving power characterize the Goodyear pump, introduced to the public in mid-January.



This remarkable pump, which is of all-British design and construction, was invented by a Cornish engineer, J. W. Goodyear, who has had over 20 years' experience in hydraulics engineering. Production is being handled by a subsidiary company of Holman Bros Ltd of Camborne.

Operating on a modification of the principle of the Archimedean screw, the new pump has only two moving parts. Almost startling reductions in weight have been achieved. For example, the model that is capable of giving 30 gpm at heads up to 300 ft weighs only 11 lb in alloy and about 18 lb in iron, compared with up to 700 lb weight for pumps of conventional design and similar capacity.

Equally notable is the reduction in power required. The Goodyear pump when delivering 30 gpm at 200 ft head needs only 3 bhp, a saving of at least 50 per cent in power consumption.

The pump is continuously self-priming, self-lubricating, and is claimed to have an efficiency exceeding 60 per cent, which is well above the standard normally attained.

New Drilling Company Formed

A new drilling contracting company has been formed between two American drilling contracting firms and the Contracting and Trading Company of Beirut. The name of the new Company is The Seacat Drilling Company. The American partners are the Southeastern Drilling Corporation of Dallas, Texas and Turnbull & Zoch of Corpus Christi, Texas.

The Seacat Company will operate in the Middle East and adjacent countries, and in North and West Africa, India, and Pakistan.

Seacat has already obtained a contract with the Iran Oil Company for drilling wells in the Qum area of Iran. The Company can provide all services for a drilling location, including construction of access roads, water supply, and transport and accommodation for personnel.

The London office is at 85 Lancaster Gate, W.2.

£1 Million Contract for Matthew Hall & Co. Ltd

Matthew Hall & Co, Ltd have been awarded a contract for the design, procurement, construction, and commissioning of the new chemicals building at the factory of Joseph Crosfield & Sons Ltd at Warrington. This covers a new chemical plant for the manufacture of industrial detergents, silica gels, and other chemicals, and is due to be completed in July 1959.

The value of the contract to Matthew Hall & Co. is approximately £1 million.

Fuel Tank Protective Covering

A special protective covering, manufactured by Arthur Holden & Sons Ltd of Birmingham and known as Epinamel A.C., has been used on the fuel-stowage tanks of the aircraft carrier H.M.S. *Victorious* as part of her complete refitting which has recently been completed.

The coating has also been adopted on other naval craft, notably on the Canadian aircraft carrier, H.M.C.S. *Bonaventure*, and on H.M.S. *Centaur*.

Welding Cable Connexions

A process for welding copper cable to steel or cast iron that requires no external heat or power source is described in a new leaflet.

Copies are available from MAPEL Ltd, Victoria Street, London, S.W.1.

New Range of Pumps for the U.K. Market

A new range of pumps, made under licence to the design of the Barnes Manufacturing Co., Mansfield, Ohio, has been introduced to the British market by Hill-Barnes (Pumps) Ltd, of Markfield, Leicester.

The pumps are claimed to prime down to 25 ft suction lift with as little as one-third of the normal water level in the pump body. There is no recirculation during pumping and the range comprises models of from 1000 to 90,000 gallons per hour.

Used-Oil Reclamation Units

Manufactured in Germany by Schlegel Brothers of Stuttgart, the Schlegel system of re-refining of used oil is now available in Britain and is being handled by Liquid Systems Ltd, Wellesley Road, Croydon.

The regenerators combine distillation, adsorption, and filtration and can be used for gasoline, kerosine, nitrosolvents, trichlorethylene, etc.

New Continental Office

Evershed & Vignoles Ltd, electrical and mechanical engineers of Chiswick, London are to open an office at 142 Rue Gallait, Brussels from 1 April.

Under the management of C. Samyn, this office will handle products for Belgium, the Belgian Congo, and Luxemburg.

Large Bore Downwell Pumps

National Supply Company's Export Division, 600 Fifth Avenue, New York, has produced a short bulletin on the features of the "Oilmaster" tubing "full liner" pumps which are designed to move maximum volumes of fluids.

National Supply is the exclusive export distributor for these pumps.

New Electronic Instruments for U.K. Market

Recently introduced to the British market by Winston Electronics Ltd, Shepperton are three instruments manufactured by Beckman Instruments, G.m.b.H.

They comprise an industrial gas chromatograph, an electrolytic hygrometer, and a leak detector.

The first is designed for continuous monitoring of industrial gas systems, and can be used to estimate water content of ethylene and methane, and the water vapour content of tank cars, etc.

The hygrometer measures water content down to one p.p.m. in gaseous or vapour samples.

The leak detector is claimed to find leaks undetectable by other means and is effective with any size leaks at any pressure range.

4 MeV Linear Accelerator for BP

A 4 million electron-volt linear accelerator has been ordered by British Petroleum Ltd for their research station at Sunbury-on-Thames.

It is believed to be the first machine of its kind in Britain to be built specifically for industrial research in the petroleum and chemical industries.

It provides a compact easily controlled source of high-energy electrons, deep-penetration X-rays, or neutrons, the last two being produced by causing the electron beam to hit a suitable target.

A special building gives adequate protection for the staff against radiation.

Design and construction of the accelerator and its associated control equipment are being undertaken by Mullard Research Laboratories on behalf of Philips Electrical Ltd, the contractors.

New Oilfield Chemical

A new oilfield chemical that is claimed to prevent gyp deposition in primary and waterflood production wells has been developed by Calgon Co., a division of Hagan Chemicals & Controls Inc., Pittsburgh.

The new stabilizing agent is a controlled solubility phosphate, formulated to prevent mineral deposition in the well bore, in flow channels adjacent to the well bore, and on downhole equipment such as pumps, rods, and screens.

Extensive field tests in waterflood projects have proved its effectiveness in preventing precipitation of such insoluble compounds as calcium carbonate, calcium sulphate, and barium sulphate.

Technical details can be obtained from the Calgon Co., Dept, 241, Box 1346, Pittsburgh 30, Pa.

Ultrasonics and Pipeline Welding

In a recent paper to the Institution of Gas Engineers, A. D. L. Copp, M.I.C.E., Distributing Engineer of the North Thames Gas Board, praised the MAPEL ultrasonic testing apparatus used on the 15½ miles of 24-inch diameter steel pipeline between Shell Haven and Romford.

He stated that ultrasonic testing was indispensable in ensuring a consistently good welding standard.

Further details are available from Metal and Pipeline Endurance Ltd, Artillery Mansions, Victoria Street, London, S.W.1.

★ ★ ★

Forthcoming Meetings

THE INSTITUTE

(*At* 61 *New Cavendish Street, London, W.*1., 5.30 *p.m.—tea* 5 *p.m.*)

Electrostatics and Explosion Hazards in the Petroleum Industry. Dr A. Klinkenberg. **2 April**

Advances in Petroleum Refining. W. J. Newby, B.Sc. **7 May**

IP ECONOMICS AND OPERATIONS GROUP

(*At* 61 *New Cavendish Street, London, W.*1., 5.30 *p.m.—tea* 5 *p.m.*)

Development of Nuclear Power. J. A. Jukes. **13 March**

1957 and its Implications for the Oil Industry. J. Senior. **10 April**

IP ESSEX BRANCH

(*At the Railway Hotel, Pitsea*, 7.30 *p.m.*)

Operation of a Small Refinery in the U.K. A. Cluer, B.Sc., A.R.I.C., A.M.I.Chem.E., M.Inst.Pet. **21 March**

Free Piston Engines. Members of staff of Alan Muntz & Co. **25 April**

IP FAWLEY BRANCH

(*At Esso* (*Fawley*) *Recreation Club, Holbury*, 7.30 *p.m.*)

Joint Meeting with the Royal Institute of Chemistry

Non-destructive Testing of Materials. J. R. Baddiley, B.Sc. **14 March**

Recent Developments in Gas Making Processes. A. E. Haffner, A.R.C.S., F.Inst.F., M.Inst.Gas Eng. **11 April**

IP LONDON BRANCH

Luncheon Meeting. **19 March**

(*At* 61 *New Cavendish Street, London, W.*1, 6 *p.m.—tea* 5.30 *p.m.*)

The British Aircraft Industry. Edward Bowyer, C.B.E. **27 March**

Britain's Part in the Oil Industry. P. M. De Veulle and F. G. Thackeray. **29 April**

IP NORTHERN BRANCH

(*At Engineers' Club, Albert Square, Manchester* 2, 6.30 *p.m.*)

Subject to be announced. **18 March**

(*At Manchester College of Science & Technology*)

Joint meeting with the N.W. Branch of the Institution of Chemical Engineers

Trends in the Petroleum Chemical Field. **24 April**

IP SCOTTISH BRANCH

(*At Recreation Hall, BP Grangemouth Refinery*, 7.30 *p.m.*)

Joint Meeting with Stirlingshire and District Section of R.I.C. and S.C.I. **20 March**

(*At North British Station Hotel, Edinburgh*, 7.30 *p.m.*)

Paints applied to Petroleum Plant. **10 April**

IP SOUTH-EASTERN BRANCH

(*At the King's Head Hotel, Rochester*, 7.45 *p.m.*)

The Work of a Public Relations Officer. D. E. Doyle, A.M.Inst.Pet.

Film: *Rhythm on the Rails.* **1 April**

IP SOUTH WALES BRANCH

(*At the Training Centre, BP Refinery, (Llandarcy) Ltd*, 5.30 *p.m.*)

Joint Meeting with the Institute of Fuel

Oil Fuel Applications with Special Reference to South Wales. T. Chippendale, A.M.I.Chem.E., M.Inst.F. **13 March**

IP STANLOW BRANCH

(*At Blossoms Hotel, Chester*, 7.30 *p.m.*)

Handling Symposium:

Bulk. M. D. Ray, A.F.Inst. Pet.

Packages: M. Ingram, M.Inst. Pet

Stocks Accounting: N. B. Gilmour. **19 March**

IP STANLOW BRANCH—*cont.*

Joint Meeting with the Institution of Chemical Engineers

Design and Manufacturer of Heat Exchangers. E. A. Saunders and R. Parker. **16 A**

OTHER SOCIETIES

THE INSTITUTION OF MECHANICAL ENGINEERS

(*At* 1 *Birdcage Walk, London, S.W.*1, 6 *p.m.*)

Petrol Injection. Three papers by E. Gay, E. W. Downing, and Dr H. Heinrich. **15 April**

Large Pipeline Projects. A. C. Hartley, C.B.E., B.Sc., F.C.G.I., M.I.C.E., M.I.Mech.E., F.Inst.Pet., M.A.S.M.E. **25 April**

SOCIETY OF CHEMICAL INDUSTRY—ROAD AND BUILDING MATERIALS GROUP

(*At* 14 *Belgrave Square, London, S.W.*1)

Some Factors Influencing the Behaviour of Bitumen Road Surfacings. G. M. Dormon and A. W. Jarman, B.Sc., A.R.I.C., F.Inst.Pet. **20 March**

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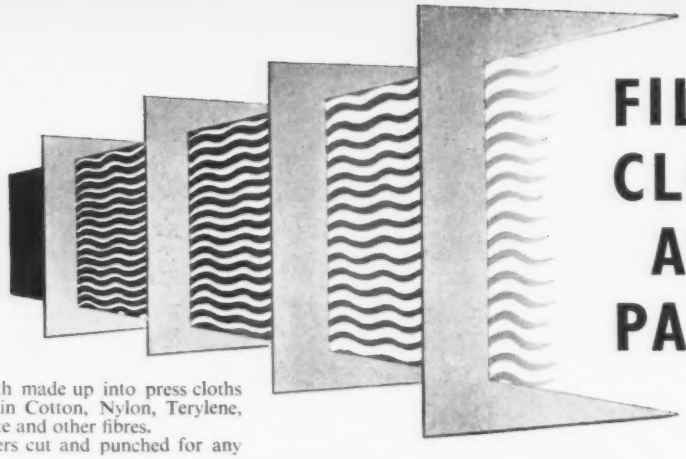

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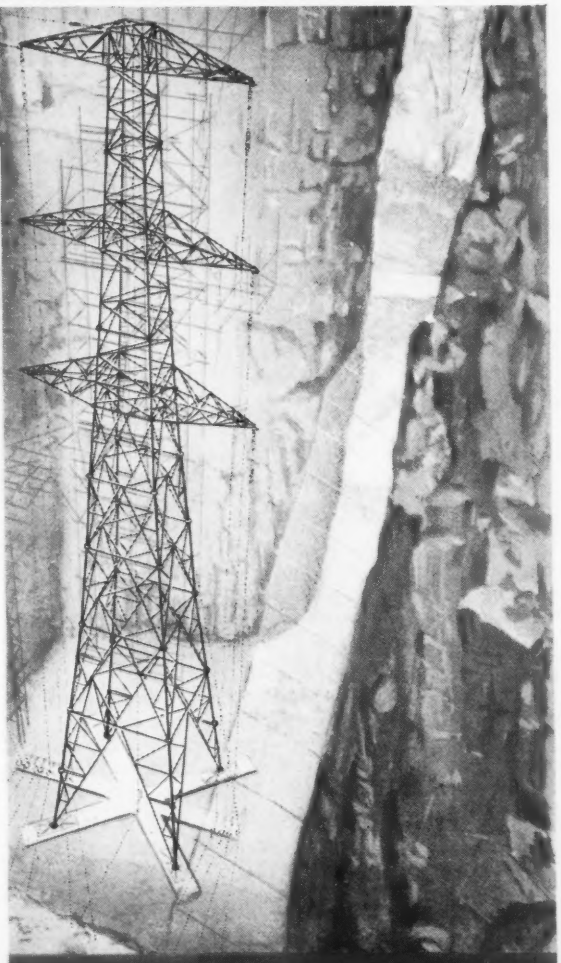
SCIENCE AND THE STEEL TUBE AGE: 3



THE MONKEY HOLE

A disused limestone quarry in Derbyshire has provided the ideal site for this unique testing station, recently opened by Stewarts and Lloyds. The floor measures 100 ft. by 60 ft. and its sheer walls, 160 ft. high, enable horizontal pulls to be applied by short ropes; they also protect structures under test against chance wind loads.

Loads up to 30 tons can be applied to any points on the structure under test by twelve 5-ton slow-speed winches installed in a building on the quarry floor, and operated from a control room where indicators show loads and deflections. Special apparatus, designed by Stewarts and Lloyds' research department at Corby, is used to measure the loads applied to the structure under test.

Many years ago an Italian organ grinder and his monkey used to entertain the quarrymen from the bridge spanning the entrance to the quarry. After the performance the monkey was lowered on a rope to make a collection. One day the rope broke and the monkey was killed: the quarry has been known as the 'Monkey Hole' ever since.

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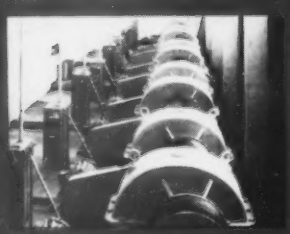
Below Left: The Test House; *Centre:* The Winches; *Right:* The Control Desk



Check List - Miniature Instruments

Recorder and Indicator

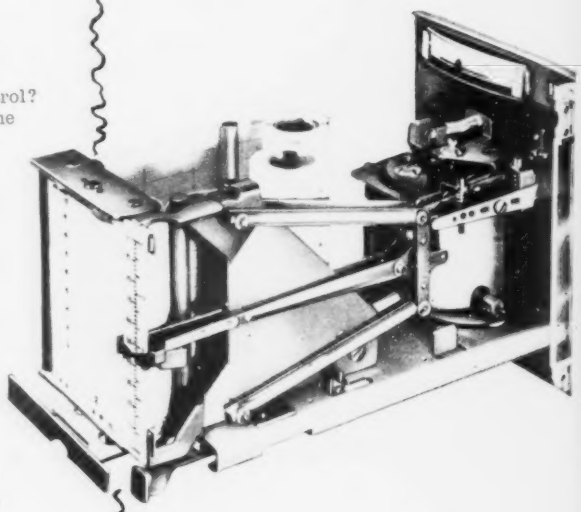
YES	NO	
✓	☐	Will the recorder or indicator work with *any* pneumatic balance controller that is available today—without adding any parts?
✓	☐	Is it easy to read . . . with large pointers and an easy-to-scan vertical scale?
		Are there two ways to switch from automatic control to manual operation:
✓	☐	. . . a *quick* method with practically no 'bump'?
✓	☐	. . . a slightly slower *precision* method with *absolutely no* 'bump'?
✓	☐	Can you adjust the regulator knob and transfer switches without covering the chart or scale with your hand?
✓	☐	Are zero and span easy to adjust?
✓	☐	Can you pull out the chassis to inspect and service all parts while they are operating?
✓	☐	Can you interchange recorder and indicator chassis in a few seconds without loss of control?
✓	☐	Can you remove the chassis and send it to the shop for repair . . .
✓	☐	. . . and while it is out, can you maintain control of the process automatically or manually?
✓	☐	Is the rear of the instrument free of all plug-in projections and seal rings, which can be lost or damaged during shipment?
✓	☐	Can the chassis be safeguarded in its original packing until start-up?
✓	☐	. . . In the meantime, can you attach the case to the panel and connect all field piping, so that you can test the air lines and even operate the valve before unpacking and adding the chassis?
✓	☐	Can the pressure regulator and pneumatic switches be removed without an electrician standing by?
✓	☐	Does the control air flow freely from the recorder to the controller, without restriction from old-fashioned valves?

Controller

✓	☐	Is there only *one* model of controller—so versatile that it can be used for every application?
✓	☐	Is the speed of response adequate to work with the best control valves available today?
✓	☐	Can you disconnect the controller by merely turning a lever?
✓	☐	Is it easy to add rate action to the controller?
		Can any maintenance man keep the system operating by quickly and easily replacing major controller components, such as the:
✓	☐	. . . pilot valve
✓	☐	. . . reset adjusting needle valve
✓	☐	. . . proportional band needle valve
✓	☐	. . . deviation measuring section
✓	☐	Are all adjustments, filters, and restrictions easy to reach?
✓	☐	Can you keep one spare on the shelf to replace *any* controller in your plant?

Someone chose

Tel-O-Set Instruments



Bulletin 7202 gives full details of Tel-O-Set Instruments.
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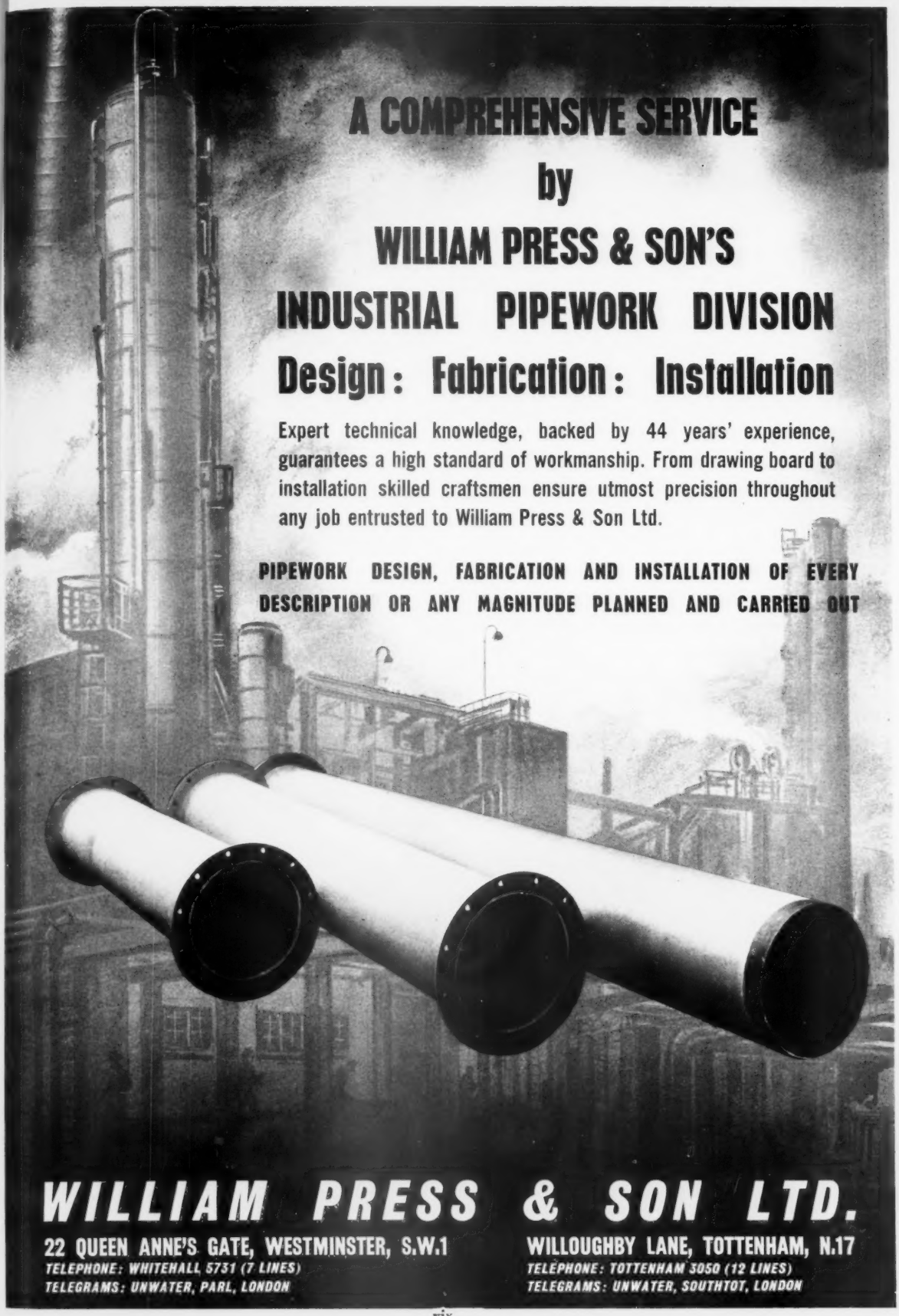

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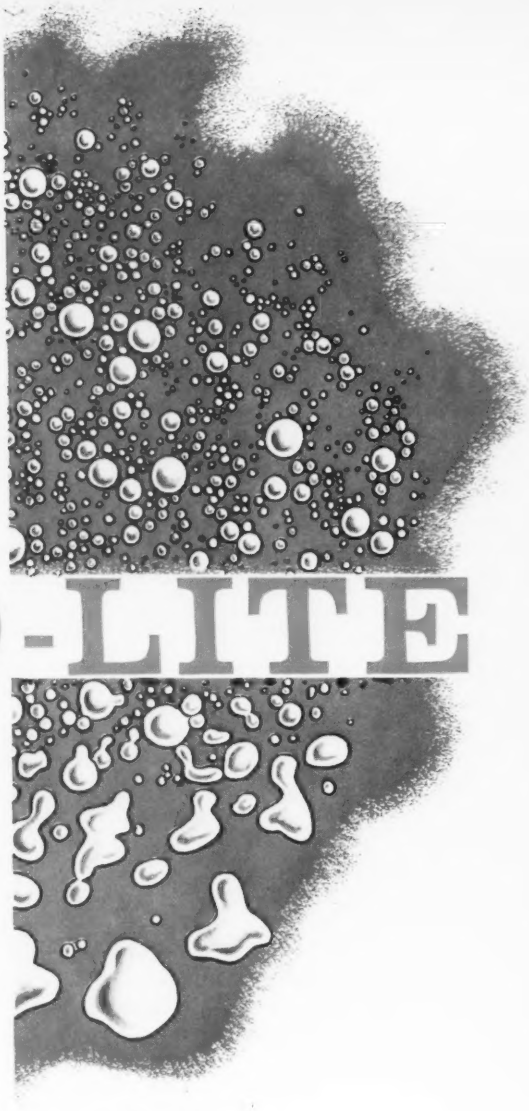

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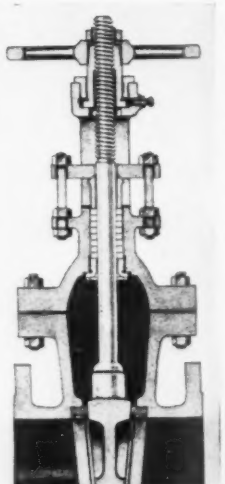
DIMENSIONS IN INCHES

	Bore	Flange Diameter	Flange Thickness	F to F	Raised Face Dia.	Raised Face	Height
CLASS 150	2	6	¾	7	3¾	1/16	18¾
	3	7½	¾	8	5	1/16	22¾
	4	9	15/16	9	6 3/16	1/16	27
	6	11	1	10½	8½	1/16	35¾
	8	13½	1⅛	11½	10¾	1/16	45
	10	16	1 3/16	13	12¾	1/16	53½
	12	19	1¼	14	15	1/16	60½
CLASS 300	2	6½	¾	8½	3¾	1/16	20¾
	3	8¼	1⅛	11½	5	1/16	24¾
	4	10	1⅛	12	6 3/16	1/16	30¾
	6	12½	1 3/16	15½	8½	1/16	39¾
	8	15	1⅜	16½	10¾	1/16	47½
	10	17½	1½	18	12¾	1/16	56¾
	12	20½	2	19½	15	1/16	63¾



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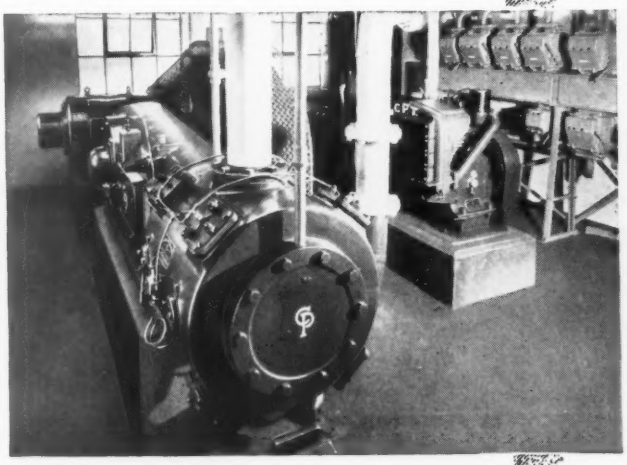

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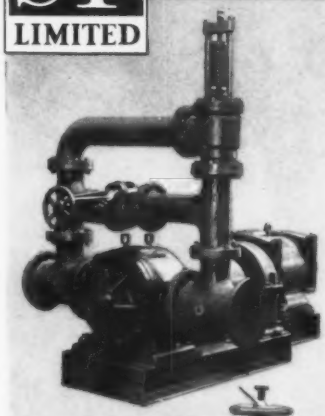
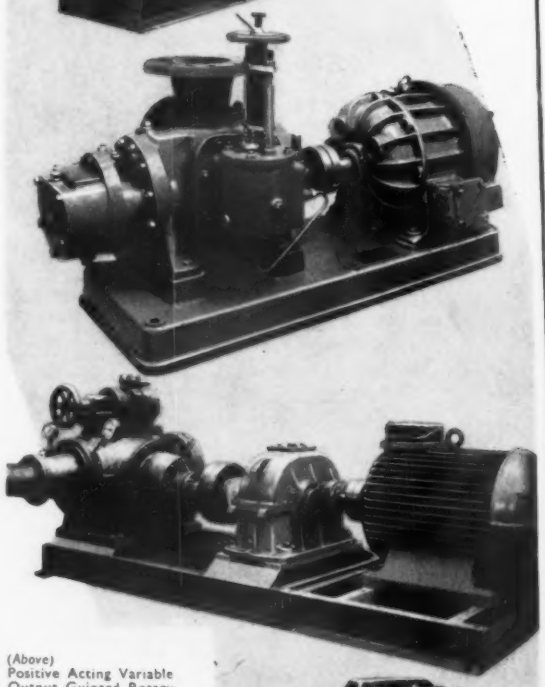


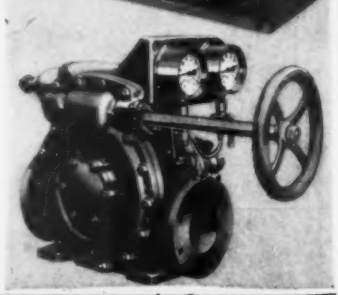
(*Left*)
Positive Acting Rotary Displacement Pump for the handling of Molasses and viscous fluids, electrically driven through totally enclosed Reduction Gear Box.

(*Below*)
Suitable for handling Spirits and other volatile fluids, this Screw Displacement Pump is of the all round clearance design and is capable of working with a high suction lift. The flow is practically pulseless and the unit self priming.



(*Above*)
Positive Acting Variable Output Guinard Rotary Piston Pump. Electrically driven through Reduction Gear Box, for Oils of varying viscosity.

(*Right*)
Reversing Flow Rotary Displacement Pump for fitting on tank wagons. These pumps are driven from a power take-off on the gear box.



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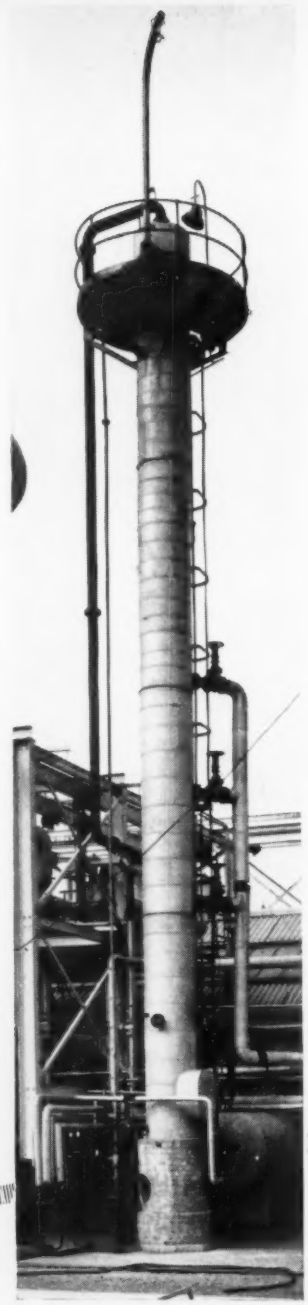

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Left: Monel distillation column incorporating 40 "Turbogrid" distillation trays of 2′ 6″ diameter at Shell Refinery, Stanlow.

On right is shown a stainless steel SO_2 drying column of the Edeleanu plant at Stanlow.

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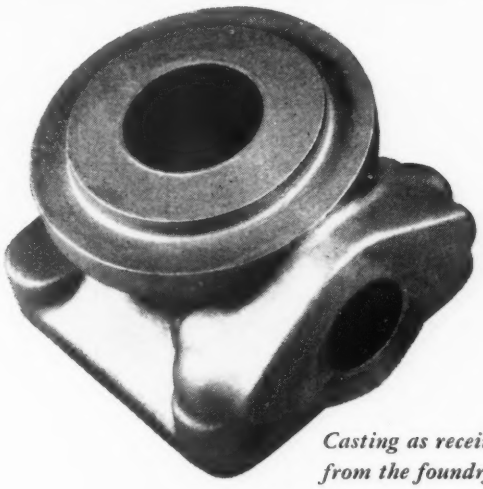
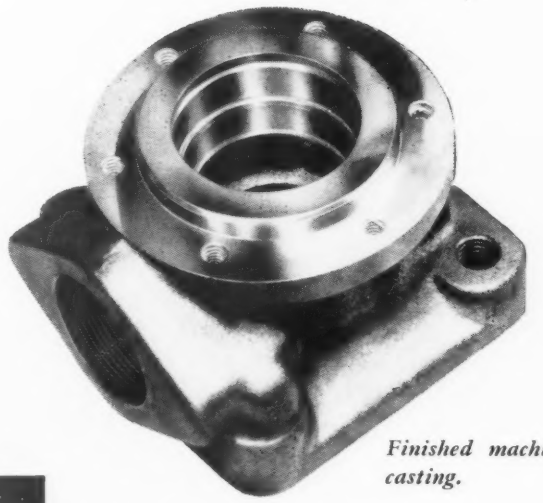


Casting as received from the foundry.



Finished machined casting.

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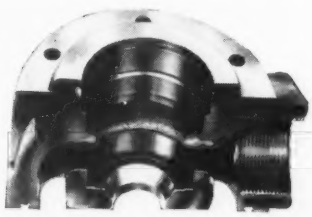

Sectioned casting showing the clean cored passages.

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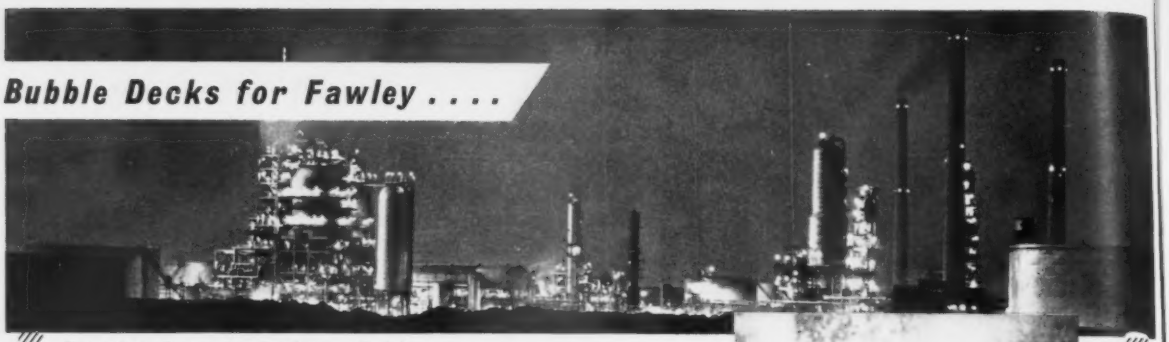

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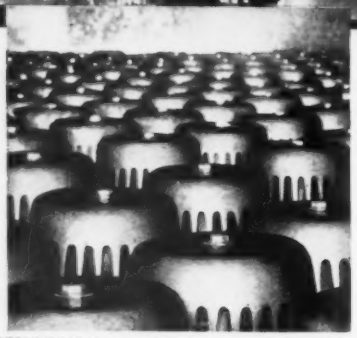

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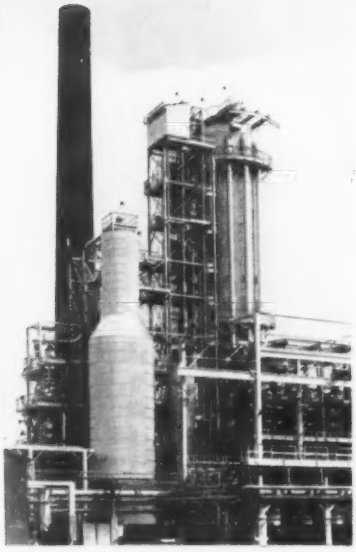

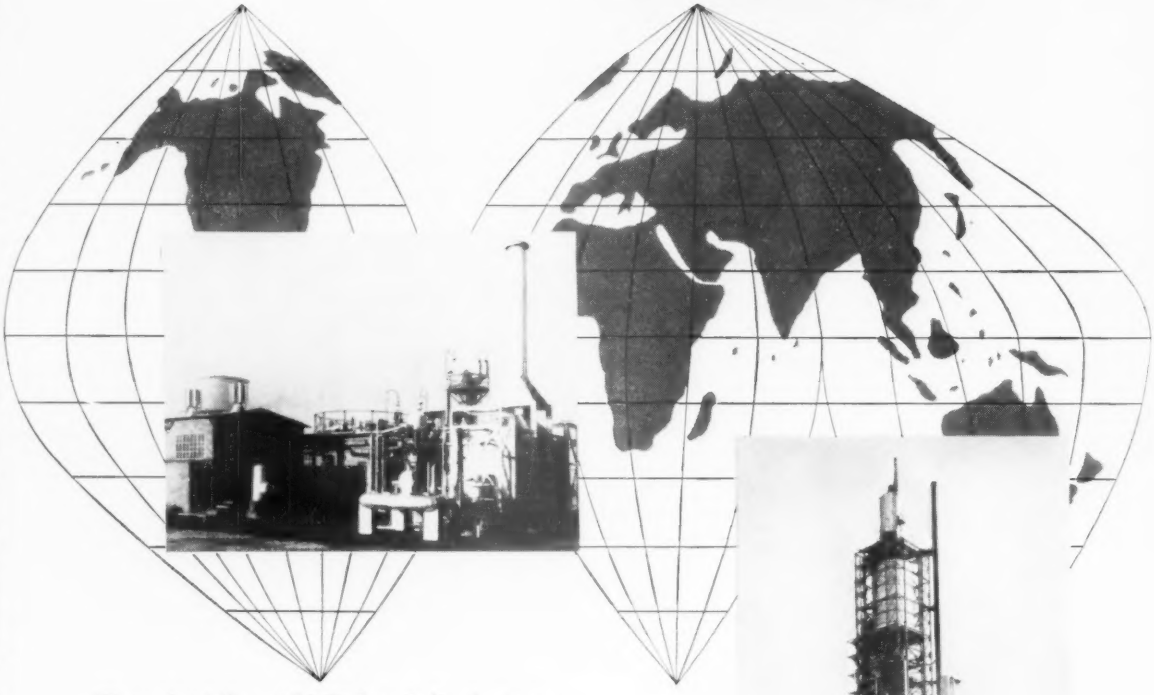

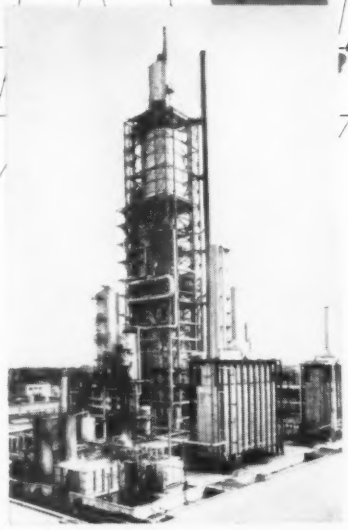

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